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AUTHORITY

ASD ltr dtd 4 May 1977

ASD/XR-TR-76-26

PRELIMINARY INFRARED RADIATION EMISSIONS PROGRAM (PIREP)

Volume II - User Manual

Aircraft Engine Group
General Electric Company
Cincinnati, Ohio 45215

15 November 1976

USER MANUAL

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Prepared for:
Deputy for Development Planning
Aeronautical Systems Division
Wright-Patterson Air Force Base, Ohio 45433

• Corrected pages inserted.
22 May '77
pfc DDC/TCA-2

ERRATA:

- Please note the enclosed corrected six pages:

  A-77, A-79, A-81, A-83

  B-64 and B-65

ASD/XR-TR-76-26, USER MANUAL - Volume II

PRELIMINARY INFRARED RADIATION EMISSIONS PROGRAM (PIREP)

ASD/XR-TR-76-26

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
ASD-XR-TR-76-26-Vol-2, CM-6-03-Vol-2

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER
ASD/XR, JTCG/AS

4. TITLE (and Subtitle)
PRELIMINARY INFRARED RADIATION EMISSIONS PREDICTION (PIREP). VOL. II USER MANUAL,

5. TYPE OF REPORT & PERIOD COVERED
USER MANUAL
May 15, 1976 - Nov. 15, 1976

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
M. E. Wilton

8. CONTRACT OR GRANT NUMBER(s)
F33615-76-C-0117

9. PERFORMING ORGANIZATION NAME AND ADDRESS
General Electric Company
Aircraft Engine Group
Cincinnati, Ohio 45215

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
362 p.

11. CONTROLLING OFFICE NAME AND ADDRESS
Aeronautical Systems Division, Air Force Systems Command, United States Air Force
Wright-Patterson AFB, Ohio 45433

12. REPORT DATE
15 Nov[redacted]976

13. NUMBER OF PAGES

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Distribution limited to U.S. Government agencies only; report contains test and evaluation information, November 1976. Other requests for this document must be referred to ASD/XRH, Wright-Patterson AFB, Ohio.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
Final, 15 May - 15 Nov 76

18. SUPPLEMENTARY NOTES
This report will be superceded by a JTCG/AS report after review and incorporation of any needed supplementary material.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Aircraft Survivability
IR Aircraft Configuration
IR Emissions Control
Preliminary IR Analysis
PIREP
IRCM Requirements

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

PIREP (Preliminary Infrared Radiation Emissions Predictions) is a computer routine for providing preliminary IR signature estimates for turbojet, turbofan and turboshaft engines. The peak plume and hot parts infrared emissions can be made available as part of the output for each and every engine, cycle, and flight condition at low cost to the user. In this way estimates of susceptability to missile threats can be included as an integral factor in preliminary engine design and realistic efforts can be made to select cycles which present low IR signatures to specific threat environments.

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Extended PIREP can also evaluate the suppression potential of several candidate engines or missions for relatively low cost during the early selection of phases of engine designs. The user can judge the potential of more advanced missiles and calculate lockon ranges for use in survivability studies or for comparison of different cycle/engine designs. Quick estimates are available to judge whether a candidate cycle can possibly meet given IR specifications before more expensive detailed studies are initiated.

FOREWORD

This report is the product of a jointly planned and corrdinated effort under cognizance of the Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS), Naval Air Systems Command, Code 5204J, Washington, D. C. 20361. The JTCG/AS is a chartered activity under the aegis of the Joint AMC/NMC/AFLC/(JTCG/AS-CM-6-01)" This effort was managed by USAF Aeronautical Systems Division, Deputy for Development Planning, ASD/XRHP, S. E. Tate, WPAFB, Ohio 45433.

The development of this program and the preparation of the report was performed by the Aircraft Engine Group of the General Electric Company, Cincinnati, Ohio.

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Publication of this technical report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

Terrell E. Horne

TERRELL E. HORNE
Colonel, USAF
Deputy for Development Planning

SUMMARY

A new design tool, the Preliminary Infrared Radiation Emissions Program (PIREP) has been developed to bring the infrared emissions considerations into the realm of configuration definition and preliminary design of aircraft.

This development sponsored by the Air Force has been achieved through the cooperation of USN/ONR code 211 and USAF/ASD/XRH in a series of studies to compile, organize, and manage the existing extensive data base of infrared knowledge and related influences on aeronautical systems survivability.

Little knowledge of IR countermeasures (IRCM) technology is necessary for the use of PIREP in comparing one engine against another or in preliminary suppression evaluations. As a design engineer becomes increasingly conversant with the problems involved, it is expected that he will increasingly utilize the options available in PIREP.

It must be emphasized that the IR signatures estimated by PIREP are good approximations; useful, quick estimates for early study purposes to identify design parameters, to develop data and to identify gross disparities between types to engine cycles. Once the designs have been reduced to a few candidate designs, then it may be desirable to apply the highly sophisticated and more accurate IR signature analysis programs.

PIREP consists of three sections; the basic module, extension I for lockon range and extension II for spectral studies. All three sections are capable of dual mode operation; attached to engine performance decks or initiated by an independent executor program which contains the input and output (I/O) functions.

It is envisioned that the basic PIREP will eventually be an integral part of engine performance decks while the extensions will be applied to independent analyses of details.

USER MANUAL

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I. INTRODUCTION

During concept definition (CD) and preliminary design (PD) activity many tens or a few hundred configurations of engine cycles and components as well as airframe components must be tentatively evaluated to evolve a desirable few candidate designs. One of these candidates then becomes designated a baseline for additional design and mission capability comparison. Obviously, many (IR emission) critical decisions have already been made at this stage. If IR emissions are to be successfully managed in aerospace systems design, it must be integrated into the CD and PD activity.

A new data management scheme, developed in this effort, is specifically tailored to make IR knowledge available for CD and PD. The Preliminary Infrared Radiation Emissions Program (PIREP), a quick inexpensive computer routine for evaluating IR emissions, was designed to be an attachment for customer engine performance decks to produce IR emission parameters along with all other engine performance parameters. PIREP is suitable, also, for inclusion in engine performance parametric decks, or it can be operated independently for more detailed or parametric studies. PIREP was developed for the U.S. Air Force under contract F33615-76-C-0117.

PIREP was initiated as a result of the IR Handbook program sponsored by the USN, Office of Naval Research (Ref. 1), a program which has concentrated on gathering current methodology, organizating the extensive data base of infrared knowledge, and increasing survivability through improvement of analytical tools.

A technique for utilizing data correlation analysis, Plume Cycle IR Parameter (PCIR) was developed under Contract N00014-74-C-0074, as a cooperative venture between USN, Office of Naval Research and USAF/ASD-XR (Ref. 1). This technique represents peak plume emissions in two wavelength bands (1.8-2.7μm and 3.9-4.8μm defined as functions of engine cycle parameters. A companion effort developed under the same contract (C-0074) provides an algorithm for engine Hot Parts Emissions, the Cycle IR Parameter (CIR).

PIREP represents the next logical step; to develop a computer routine to express these prediction methods.

II. GENERAL DESCRIPTION

A. PIREP System

PIREP is a computer program for rapidly generating turbine engine IR emissions intensities and distribution for use with aircraft engine performance decks used by the government. The program operates in two independent modes: in connection with and attached to engine performance decks used by the Government or supported by a self-standing independent executor program. Each initiator will provide the input and output (I/O) functions. As a minimum, input will require some description of engine and exhaust system, aircraft configuration, observing system and scenerio. Typical input data will include: T5, turbine discharge temperature, °R; T7, exhaust exit temperature, °R; A8, exhaust throat area, in^2; P8 exhaust total pressure psia; PAMB, ambient pressure, psia; TAMB, ambient temperature, °R; V19, secondary flow velocity, ft/sec; XM, flight Mach number; ALT, altitude, K ft.; and FAR, fuel air ratio at the exhaust exit plane. The cycle parameter information is transmitted to the basic PIREP which computes the preliminary source IR numbers and feeds the results back to the initiator for output. The parameter END, also in the calling sequence, determines whether or not the program proceeds to the extended routines for additional studies.

PIREP is composed of three main sections: (a) Basic PIREP, (b) Range Extension (I), and (c) Spectra Extension (II). These sections, represented in the flow chart of Figure 1, are discussed in more detail below. The Range Extension (I) of PIREP facilitates a quick study of lockon ranges for nominal IR seeking missiles, and evaluation of candidate IR emission management schemes. The Spectra Extension (II) facilitates spectral analysis for consideration of specific missiles, special filters, or more refined IR emission management schemes. It is envisioned that the Basic PIREP will eventually be an integral part of engine performance decks, but the two PIREP extensions will continue to be utilized for detailed independent design analysis.

B. Basic PIREP with Cycle Deck

The Basic PIREP uses less than 1K (octal) storage. It computes the preliminary cycle IR numbers for plume(PCIR1, PCIR2) and hot parts (CIR1, CIR2) where 1 and 2 refer to the wavelength bands, 1 -2.7μm and 3.9-4.8μm respectively. These are representative of bands for hot parts and plume seeking missiles. The hot parts numbers are the source radiations near tail-on to the aircraft which usually are the maximum hot-part IR emissions available to a missile. The plume numbers are source radiations normal to the exhaust system centerline and are usually the maximum plume emissions available to a missile.

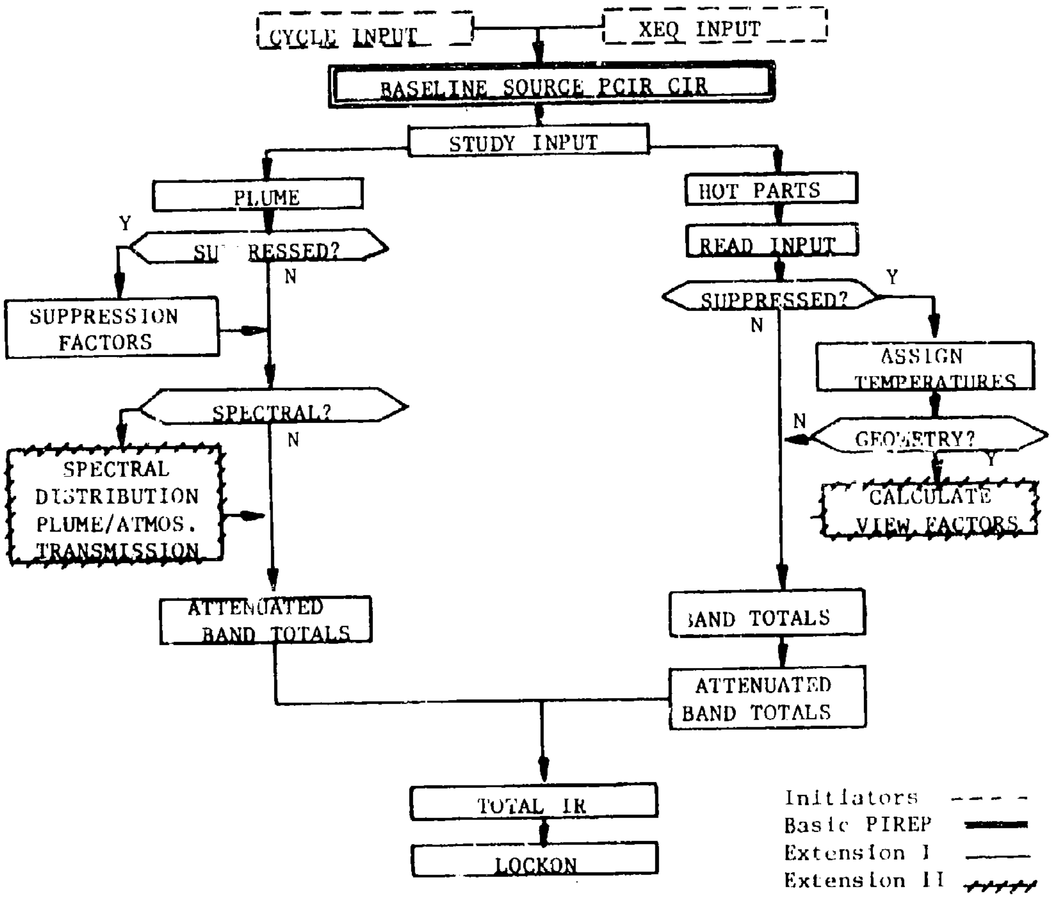

Figure 1. Schematic Diagram of PIREP System

To use PIREP in an engine cycle deck, some routine of the deck itself must be modified to "Call PIREP" at the end of each cycle point evaluation. This is most conveniently added in the output or print routine. In addition, a write statement and format statement must be added to the output routine for presenting the PCIR numbers. The specific statements to be included into a cycle deck are:

```
      CALL PIREP(ARG1,ARG2,ARG3,ARG4,ARG5,ARG6,ARG7,
     + ARG8,ARG9,ARG10,CIR1,CIR2,PCIR1,PCIR2,END)

      WRITE(6,XXXX) PCIR1,PCIR2,CIR1,CIR2

XXXX  FORMAT(//20X,10HIR INDICESS//
     + 15X,8H1.8-2.7,4X,7H3.9-4.8//
     + 2X,5HPLUME,2X,2F12.0/
     + 2X,7HHOT PTS,2F12.0)
```

where

ARG1 = exhaust total temperature, °R
ARG2 = turbine discharge temperature, °R
ARG3 = exhaust throat area, in^2
ARG4 = total pressure at exhaust exit, psia
ARG5 = ambient pressure, psia
ARG6 = ambient temperature, °R
ARG7 = secondary flow velocity, ft/sec.
ARG8 = flight Mach number
ARG9 = fuel-to-air ratio
ARG10 = altitude, K ft.

If basic PIREP only is being used ARG9 and ARG10 are not used.

C. Basic PIREP with Executor

The executor routine operates in two modes:

- Since it provides cycle data input directly, it may be used to compute basic cycle IR parameters for a number of cycles in sequence. For this purpose the parameter, END, need not be supplied initially and the program will keep returning for additional cycle information until END is input equal to -1.

- END must be set equal to 99 if the PIREP extensions are to be used. END = 99 also accesses the extension routines directly from the cycle deck.

The basic CIR parameters are restricted to source emissions for hot parts near tail-on and plume at 90° aspect angle for two specific wavelength bands: 1.8-2.7μm and 3.9-4.8μm

D. Range Extension I

Extension I is restricted to the same two wavelength bands mentioned above. For these bands, it can calculate atmospheric attenuated radiation, the effect of nozzle shape on plume emissions, simple 2-element cooling or coating emissions for hot parts suppression, and lockon ranges for typical missiles in both wavelength bands. This permits limited studies for the evaluation of suppression concepts applied to specific engine cycles and for comparison of vulnerability envelopes.

E. Spectra Extension II

Extension II provides for approximate spectral distribution of plume emissions and plume/atmospheric transmissivities and for evaluation of a 6-element nozzle exhaust system with centerbody. It also enables the user to evaluate roughly the effects of partial surface coatings, of coolants, and of blockage on vulnerability to advanced missile threats.

III. INPUT/OUTPUT

A. Discussion

A series of seven sample problems have been prepared to exercise all of the options available in basic PIREP and its extensions. The sample problems are grouped according to the PIREP model being employed and in a sequence that might be used in actual practice. The completed exercise involves:

- o Sample 1. Comparison of two different engines at several flight conditions.
- o Sample 2. Evaluation of preliminary signature and lock-on for one engine and one flight condition (I-2).
- o Sample 3. Evaluation of plume suppressor capabilities with special lockon options also for the I-2 case.
- o Sample 4. Preliminary study of hot parts suppression.
- o Sample 5. Evaluation of two engine configurations for the 1-2 case of sample 1 with different cooling and coating schemes.
- o Sample 6. Study of spectral IR signature and lockon for the I-2 case.
- o Sample 7. Evaluation of lockon for an advanced missile including airframe emissions external to the exhaust system.

Each of these exercises has been handled as if it were part of a real problem in evaluation of engines and cycles during preliminary design

The information pertaining to each operational mode of PIREP should be thoroughly digested before any attempt is made to use that portion of the program in an actual situation.

The input sheets to be used with PIREP are discussed in the following section prior to the presentation of the sample problems.

B. Input Sheets

There are 4 pages of input for use with PIREP. The input parameters used are briefly defined on each page. Namelist input is used throughout. A general description of the input sheets follows.

1. Executor Input

The input to the executor routine is an alternative to input derived directly from a cycle deck. It provides the necessary engine information

to define the engine and cycle conditions for plume and hot parts IR source missions and subsequent studies as requested.

2. Title - General Information

Two lines of alphanumeric title identify the case being analyzed. This input is not namelist but is formatted for 60 spaces of alphanumeric characters per line.

Observer Location

A parametric study of observer locations indicated by ranges, azimuth angles, and elevation angles may be specified.

Plume Suppression

Plume suppression is restricted to nozzle shape and engine exhaust gas variations. Nozzle shape investigations consist of altering the exhaust shape from round to rectangular shapes of specified aspect ratios.

3. Missile Description

Lockon studies may be performed for missiles with typical characteristics or for missiles with characteristics supplied by the user. In addition, spectral output and IR emissions in specified wavelength bands may be obtained without requesting lockon ranges.

4. Hot Parts Suppression

Hot parts suppression can be achieved by cooling, coating or blockage. Simple parametric studies involving these suppression techniques for assymetric bodies can be specified. An estimated of external aircraft surface area, emissivity and temperature can also be supplied.

EXECUTOR INPUT

$ CYCLE

T5 = ________, T7 = ________, A8 = ________, P8 = ________,

PAMB = ________, TAMB = ________, XM = ________, V19 = ________,

ALT = ________, FAR = ________, END = ________, $

Mnemonic	Description	Units
T5	Turbine Discharge Temperature	°R
T7	Exhaust Exit Temperature	°R
A8	Throat Area	in^2
PAMB	Ambient pressure	psia
TAMB	Ambient temperature	°R
V19	Secondary flow velocity	ft/sec
XM	Flight Mach number	--
ALT	Altitude	K feet
FAR	Fuel-air ratio at exit	
END	Extension Option ≠ 99 calculate PCIR parameters and return = 99 calculate PCIR parameters, continue into extensions and stop = -1 stop calculations (for use with executor routine only)	

GENERAL INPUT FOR EXTENSIONS

COLUMN 2	DESCRIPTION	UNITS	NOTES	MANDITORY OPTION
________________________	Two lines		Formatted Input (10A6)	(M)
________________________	of title			(M)
$INPUT				(M)
Observer Locations				(M)
ASP = ____, ____, ____, ____, ____, ____, ____, ____, ____, ____,	Tail azimuth angles relative to exhaust centerline. Tail-on=0	degrees	Max=10	(M)
RANGE = ____ (0), ____, ____, ____, ____,	Range to Observer	feet	Max=5	(M)
THTA = ____ (0), ____, ____, ____, ____,	Elevation angle to observer	degrees	Max=5	(O)
Plume Suppression:				
ASPL = ____ (1.0), ____, ____, ____, ____,	Aspect ratio for Rectangular exhaust shape (except that 1.0=round)		Max=5	(O)

Note: Initialized values are noted in parenthesis under the space allotted for the input value.

MISSILE DESCRIPTION

Extension I	Description	Units	Notes	Manditory/ Optional
NLOCK = ____, (1) (1.8-2.7)(4.0-4.8)	=2 for lockon calculation specified bands			(0)
SN = ____, ____,	Signal to Noise Ratio	-	Input if NLOCK =2	(0)
BSNS = ____, ____,	band sensitivity			
NEI = ____, ____,	noise equivalent irradiance	Watts/cm^2		
Extension II				
AMI = ____, ____, ____, ____, ____,	Initial and final wavelength defining missile band	Microns		(0)
AME = ____, ____, ____, ____, ____,				(0)
SN = ____, ____, ____, ____, ____,	signal-to-noise ratio	Microns	Max=5	(0)
BSNS = ____, ____, ____, ____, ____,	band sensitivity		Max=5	(0)
NEI = ____, ____, ____, ____, ____,	Noise equivalent input	Watts/cm^2	Max=5	(0)
NLOCK = ____, (1)	=2 will use reference characteristics as 2 of 5 permissible bands.			
SPEC. = ____, (0)	=1 will calculate spectrally but not print =0 will print spectral output, if spectral results are calculated =2 will calculate spectrally and print even if spectral results are not used.			

Input	Description	Units	Notes
NE = ____$	Number of exhaust configurations		
$ENGINE			
TM = ____, EM ____,	Temperature/Emissivity	°R	data for a surface external to the exhaust
AR = ____, ____, ____, ____, ____, ____,	Area for each aspect angle		
Extension I:			
TW = ____, ____,	Temperature	°R	
EMS = ____, ____,	Emissivity		
XI = ____, ____, ____, ____, ____, ____,	Portion of exhaust area associated with TW(1) for each aspect angle	in^2	
Extension II:			
TW = ____, ____, ____, ____, ____, ____, ____,	Surface Temperature	°R	*
EMS = ____, ____, ____, ____, ____, ____,	Surface emissivity		*
X1 = ____, ____, ____, ____, ____, ____, ____,	Coordinates of exhaust flow outer boundary	in	*
Y1 = ____, ____, ____, ____, ____, ____, ____,			
XC = ____, ____, ____, ____, ____, ____,	Coordinates of exhaust flow inner boundary	in	*
YC = ____, ____, ____, ____, ____, ____,			
$			

* Note: Surfaces and temperatures must be input in order of outer flow boundary from turbine to exit plane; then inner flow boundary from turbine to end of centerbody. A maximum of six surfaces may be specified. One additional temperature may be input to represent the turbine if different from T5 input on page 1.

IV. SAMPLE PROBLEMS

A. TEST PROBLEM I - Engine/Cycle Comparisons (EXECUTOR ONLY)

Objective: To compare the IR emissions from a mixed flow engine to a separated flow engine at 3 flight conditions: sea level static; sea level, M=1.0; and M= 2 at 50K feet altitude.

1. Discussion of Input - For this study, it is assumed that both engines have been sized to give the same thrust at sea level static condition. The cycle data is available from independent sources and presented in Table I. Use will be made of the executor routine and the basic PIREP routine only. Input cards are listed in the Table II.

2. Input Instructions - (for card listing see Figure 2)

a. Executor: Cycle values are input for all parameters for each engine/flight condition being evaluated.

b. General Input: Not applicable

c. Missile Description: Not applicable

d. Hot Parts Suppression: Not applicable

3. Description of Output: The PIREP printout is presented in Appendix A-I. There is one set of output for each case submitted. The output consists of a tabulation of the input quantities and the IR indices. These numbers estimate peak source radiation in the 1.8-2.7μm and 3.9-4.6μm bands for plume and hot parts.

4. Discussion of Results: The results of Test Problem I are summarized in Table I.

As expected engine I with a mixed flow cycle exhibits higher hot parts emissions (because the exhaust area is larger) but lower plume emissions (because the exhaust gas mixed temperature is lower). This comparison is true here for both wavelength bands and for all three flight conditions.

For our sample problem, it will be easier to suppress hot parts than plume and engine I is therefore selected for further studies. In addition, condition 2 will be selected for further studies because it is more representative of the threat environment. (These are arbitrary decisions for our sample problems; a differen. selection might be made for a different application.)

```
$CYCLE
T5=1992,T7=1415,A8=511.3,P8=42.53,
PAMB=14.7,TAMB=520,XM=0,V19=0,
ALT=0,FAR=.0126$
$CYCLE
T5=2008,T7=1388,A8=534.6,P8=56.82,
PAMB=14.7,TAMB=520,XM=1.,V19=0,
ALT=0,FAR=.0108$
$CYCLE
T5=2031,T7=1402,A8=529.8,P8=20.64,
PAMB=1.682,TAMB=380,XM=2.,V19=0,
ALT=50,FAR=.0099$
$CYCLE
T5=1992,T7=1992,A8=320.7,P8=42.696,
PAMB=14.7,TAMB=520,XM=0,V19=1540.7,
ALT=0,FAR=.0252$
$CYCLE
T5=2008,T7=2008,A8=311.9,P8=55.36,
PAMB=14.7,TAMB=520,XM=1,V19=1805.7,
ALT=0,FAR=.0243$
$CYCLE
T5=2031,T7=2031,A8=298.1,P8=19.77,
PAMB=1.682,TAMB=380,XM=2,V19=2353.1,
ALT=0,FAR=.02356$
$CYCLE END=-1$
```

Figure 2. Listing of Input Cards for Test Problem 1.

Table 1. Cycle Data Input and Peak IR Emissions Output for Problem 1.

Input Conditions

	ENGINE 1			ENGINE 2		
Condition	1	2	3	1	2	3
T7	1415	1388.3	1401.8	1992	2008.1	2031.4
T5	1992	2003.1	2031.4	1992.	2008.1	2031.4
Tamb	520.	520.	380.	520.	529.	380.
P8	42.53	56.82	20.64	42.696	55.36	19.774
Pamb	14.7	14.7	1.682	14.7	14.7	1.682
A8	511.3	534.59	529.8	320.7	311.9	298.1
XM	0	1.0	2.0	0	1.0	2.0
V19	0	0	--	1540.7	1805.7	2353.1
FAR	.0126	.01080	.0099	.0252	.0243	.02356
ALT	0	0	50	0	0	50
RESULTS						
PCIR1	25.	17.	1.0	205	241	17
PCIR2	362	349	107	1028	1410	671
CIR1	1836	2010	2127	1151	1171	1197
CIR2	1211	1298	1334	759	757	750

B. TEST PROBLEM II: Signature and Lockon (Extension 1)

Objective: To determine the IR signature and lockon ranges for engine I at condition 2.

1. Discussion of Input: The IR characteristics for cycle 1-2 will be evaluated for aspect angles 0, 30, 60, 90, 130 and 170 degrees at ranges of 0, 5000, 50,000, and 100,000 feet at zero elevation only (horizontal to the aircraft). Aspect angles are relative to the exhaust system centerline with tail-On equal to zero degrees.

2. Input Instructions: (For card listing, See Figure 3)

a. Executor: Cycle values are input for selected engine/flight conditions (1-2). END is set to 99 to signal extension calculations.

b. General Input:

Specify (1) 2 lines of title
(2) aspect angles (ASP)
(3) range (RANGE)
THTA, ASPI not applicabl

c. Missile Description: Set NLOCK=2 to signal lockon calculation using internally supplied missile characteristics.

No other input applicable.

d. Hot Parts Suppression: Use NE-1 one engine only. Use basic unsuppressed engine assumptions. No additional input needed.

```
$CYCLE
T5=2008,T7=1388,A8=534.6,P8=56.82,
PAMB=14.7,TAMB=520,V19=0,XM=1,ALT=0,
FAR=.0108,END=99$
                    PIREP TEST PROBLEM  2
                    SIGNATURE AND LOCKON
$INPUT
ASP=0,30,60,90,130,170,
RANGE=0,5000,50000,100000,
NLOCK=2,NE=1$
$ENGINE $
```

Figure 3: Listing of Input Cards for Test Problem 2.

3. Description of Output

Page - Cycle input and PCIR numbers, as described in the Test Problem 1 are given in addition to the following missile characteristics:

(1) The missile number for later reference
(2) The wavelength band associated with the missile (microns)
(3) The sensitivity of the missile over the entire band. This is dimensionless number relating to the degradation of the signal near the perimeter. There is a spectral sensitivity associated with each missile which is accounted for in this program by cutting off the wavelength bands at the 50% sensitivity.
(4) NEI is the noise equivalent input of the missile internal system (watts/cm^2)
(5) S/N is the ratio of the signal-to-noise necessary to achieve lockon for the given missile.

Page - The input values pertaining to the case being calculated are listed.

Page - Exhaust hot parts output includes:

(1) The projected areas for each node at each aspect angle. For the simplest case there is one node at exhaust exit temperature and area.
(2) The total emissions for each aspect angle and wavelength band are listed. The plume and hot parts IR totals are given for each wavelength band

Pages - Input values and output totals for both cases.

Page -

Lockon range in feet for each missile, each angle.

4. Discussion of Results: A summary of the results of the output for problem II are presented in Table 2. The major areas of vulnerability are plume emissions near broadside in the 3.9-4.8 m band and hot parts emissions from tail-on to broadside in both bands as expected.

Suppression studies will be conducted for the plume by using rectangular shaped nozzles for hot parts by using coating, cooling and shielding schemes.

Table 2: Signature and Lockon Ranges for Basic Cycle

Aspect Angle	Distance (K ft)	1.8-2.7μm Plume (Watts/Steradian)	1.8-2.7μm Hot Parts (Watts/Steradian)	3.9-4.8μm Plume (Watts/Steradian)	3.9-4.8μm Hot Parts (Watts/Steradian)
0°	0	1.4	2010	30.4	1298
	5	.02	828	1.25	664
	50	.003	424	.113	426
	100	.003	303	.074	353
Lockon Range (K Ft)		30.508		118.20	
30°	0	8.3	1741	175	1124
	5	.14	717	7.18	575
	50	.02	367	.65	368
	100	.015	262	.43	305
Lockon Range (K ft)		28.7		111.3	
60°	0	14.4	1005	303	649
	5	.24	414	12.4	332
	50	.031	212	1.12	212
	100	.026	151	.736	176
Lockon Range (K ft)		22.7		86.9	
90°	0	16.6	0	349	0
	5	.27	0	14.4	0
	50	.035	0	1 30	0
	100	.030	0	.85	0
Lockon Range (K ft)		2.3		12.9	
130°	0	12.7	0	268	0
	5	.21	0	11.0	0
	50	.03	0	.99	0
	100	.02	0	.65	0
Lockon Range (K ft)		2.2		119.	
170°	0	2.9	0	60.7	0
	5	.05	0	2 49	0
	50	.01	0	.23	0
	100	.005	0	.15	0
Lockon Range (K ft)		1.8		7.5	

C. TEST PROBLEM III - Plume Suppression

Objective: To determine the effect of nozzle shaping on the plume emissions for engine/cycle I-2.

1. Discussion of Input - For the engine cycle I-2, aspect ratios of 4 to 10 are compared to the round jet (aspect ratio = 1) for 3 elevation angles (0, 45, 90) and 2 ranges (0, 50K feet). For this study, use only the 90° aspect angle where peak plume emissions occur.

To exercise the options, the lockon ranges will be evaluated for modified less sensitive missile characteristics in the basic bands with characteristics specified in Table 3.

Table 3. Modified Missile Characteristics

Wavelength Band	Band Sensitivity	NEI	S/N
1.8-2.7	.5	3×10^{-9}	4
3.9-4.8	.7	8×10^{-10}	1.0

2. Input Instructions (For card listing see figure 4)

   a. Executor: same as in Test Problem II

   b. General Input

      Specify: (1) 2 lines of title
      (2) aspect angle (ASP)
      (3) range (RANGE)
      (4) Elevation angle (THTA)
      (5) Aspect Ratio (ASPI)

   c. Missile Description

      Specify: SN, NEI, BSNS and NLOCK = 2

   d. Hot Parts Suppression

      Same as Test Problem II

```
$CYCLE
T5=2008,T7=1388,A8=534.6,P8=56.82,
PAMB=14.7,TAMB=520,V19=0,XM=1,
ALT=0,FAR=.0108,END=99$
                    PIREP TEST PROBLEM 3
                    PLUME SUPPRESSION
$INPUT
ASP=90,
RANGE=0,50000,
THTA=0,45,90,
ASPI=1,4,10,
NE=1,NLOCK=2,
SN=4,1,BSNS=.5,.7,
NEI=3.E-10,8.E-10$
$ENGINE $
```

Figure [illegible]: Listing of Input Cards for Test Problem 3

Description of Output (Appendix A-III)

The output is similar to that of test problem II except that the missile characteristics on page one conform now to the input values and since all cases were at 90° aspect, there is not hot parts output.

Discussion of Results

The plume suppression results are summarized in Table 4. The lockon range for the plume seeking missile has been decreased from 12.4K feet to 8.[illegible] K feet for the broadside view (0=0°) and to 5.9 K feet for the narrow side view (0=90°) at an aspect ratio of 10. This is an 86% reduction of plume emissions viewed from the broadside and a 97% reduction viewed from the narrow side. One must conclude that significant plume IR reductions can be achieved with nozzle shaping. However, the lessened vulnerability is not without cost. Part of the reduction is caused by increased mixing in the flowfield induced by eddies off the corners of the rectangular exhausts, which increase drag and decrease performance. Also, a rectangular nozzle is heavier than an equivalent round nozzle. The advantages must, therefore, be weighed against the disadvantages for a given mission/threat environment.

Table 4. Plume Suppression Results

A. 1.8 - 2.7μm

Elevation Angle	Aspect Ratio	Emissions at 0 Feet (Watts/Ster.)	Emissions at 50K Feet	Lockon Range (K Ft.)
0	1.0	17	0.03	1.4
	4.0	6.6	0.01	1.0
	10.0	2.3	0.005	0.7
45°	1.0	17	0.03	1.4
	4.0	5.7	0.01	1.0
	10.0	1.8	0.004	0.7
90°	1.0	17	0.03	1.4
	4.0	3.7	0.008	0.9
	10.0	0.51	0.001	0.5

B. 3.9-4.8μm

Elevation Angle	Aspect Ratio	Emissions at 0 Feet (Watts/Ster.)	Emissions at 50K Feet	Lockon Range (K Ft.)
0	1.0	349.0	1.3	12.4
	4.0	167.0	0.62	9.7
	10.0	95.0	0.35	8.1
45°	1.0	349.0	1.3	12.4
	4.0	152.0	0.56	9.4
	10.0	78.3	0.29	7.6
90°	1.0	349.0	1.3	12.4
	4.0	114.7	0.43	8.6
	10.0	37.2	0.14	5.9

TEST PROBLEM IV - Hot Parts Suppression I

Objective: To make a quick study of potential for suppression by cooling of hot parts.

1. Input Discussions: The nominal temperature for hot parts was 2008°R, the exhaust exit total temperature. For this study assume cooling of hot parts can be achieved such that

a) 1/4 the area is cooled to 1500°R
b) 1/2 the area is cooled to 1500°R
c) all the area is cooled to 1500°R

The emissions are evaluated for 0° and 30° only at ranges of 0 and 50K feet. No lockon is calculated.

2. Input Instructions: (For card listing see Figure 5)

a) Executor - Same as test problem II
b) General Input
Specify (1) 2 lines of title
(2) aspect angles
(3) ranges
no other input is applicable.
c) Missile Description
No input applicable

d) Hot Parts Suppression: Number of exhaust systems being studied is 3.

For each case, surface temperatures are 2008°R and 1500°R. The emissivities are assumed to equal 1. The portions of the surface associated with temperature 1, 2008°R, and .75, .5 and 0, respectively.

No other input is applicable

NOTE: A separate $ENGINE namelist must be supplied for each variation of exhaust system.

3. Description of Output: The description of output for this problem is identical to that for problem II except for the exhaust hot parts output. Here, since two nodes (or areas) are involved, the output has been separated so that the emissions from each node cah be studied separately. Column headings are not particularly meaningful for this problem and so will be discussed fully under TEST PROBLEM V.

4. Discussion of Results: The results of this study are summarized in Table 5. A significant reduction in hot parts IR emissions (∿85%) will be achieved if the source temperature can be reduced to 1500°R. Even this much reduction will not be sufficient to achieve a desirable degree of invulnerability. A more detailed study is necessary to discover whether a realistic level can be achieved.

```
$CYCLE
T5=2008,T7=1388,A8=534.6,P8=56.82,
PAMB=14.7,TAMB=519,V19=0,XM=1,
P8=56.82,
ALT=0,FAR=.0108,END=99$
                    PIREP TEST PROBLEM  4
                    HOT PARTS SUPPRESSION I
$INPUT
ASP=0,30,
RANGE=0,50000,
NE=3$
$ENGINE
TW=1500,2008,
EMS=1,1,
XI=.25,.25$
$ENGINE
TW=1500,2008,
XI=.5,.5$
$ENGINE
TW=1500,XI=1,1$
```

Figure 5: Listing of Input Cards for Test Problem 4

Table 5. Hot Parts Emissions for Various Exhaust Configurations (Watts/Ster.)

Configuration	0°				30°			
Range (K ft.)	1.8 - 0	2.7 - 50	3.9 - 0	4.8 - 50	1.8 - 0	2.7 - 50	3.9 - 0	4.8 - 50
X = 0.0	2010	424	1298	426	1741	367	1124	368
X = 0.25	1533	333	1118	356	1378	289	1117	309
X = .5	1153	242	908	287	1006	210	934	248
X = 1.0	324	59	487	149	263	51	570	130
A-1	2237	473	1416	463	839	176	684	224
A-2	1125	238	759	248	784	165	678	222
A-3	1439	305	909	297	746	157	559	183
A-4	1133	241	730	239	691	146	529	173
B-0	1851	560	1253	560	2016	425	1314	429
B-1	100	21	201	66	449	94	386	126
B-2	66	14	148	48	420	89	341	117
B-3	27	5	138	45	388	82	331	108

TEST PROBLEM V - Hot Parts Suppression II

Objective: To study in detail suppression concepts for engine configurations having the same cycle conditions.

1. Discussion of Input: Two candidate configurations will be evaluated in both unsuppressed and suppressed modes. Schematics of the basic configurations are shown in Figure . Each is the same length, turbine area, throat area, and exit area. Configuration B has a plug centerbody to hide the hot turbine emissions.

The study suppressed configurations will follow the schedule of Table 6. Cooling of a surface is assumed when the temperature is lowered; coating of the surface is assumed when the emissivity is changed.

Configuration A-0 is a schematic representation of the baseline unsuppressed exhaust system. The visible interior surfaces are at 2008°R (EGT), the nozzle flap is cooled to 1388°R and the turbine runs about 5% higher at turbine discharge temperature, TDT = 2108°R. The surface emissivities are given nominal values (.65) which is in the normal range for exhaust system applications. The system is represented by five surfaces:

(1) the upstream center exhaust flowpath boundary
(2) the downstream outer exhaust flow boundary surface
(3) the nozzle flap
(4) the centerbody
(5) the turbine exit plane

Configuration B-0 is a schematic of a plug nozzle configuration with the same A8 and A9. The purpose of the plug is to hide the hot parts of the inner exhaust system from view. Some plug configurations extend beyond the exit plane and provide additional hot parts emissions from side aspects. This is not a large factor in our problem because the plug ends at the exhaust plane and at the off tail-on angles. The aerodynamics associated with this particular configuration would be so bad as to prohibit its use but for IR considerations only; it is representative of a real solution. Configuration B is also cooled and coated according to the schedule in Table VI. There are 6 surfaces to consider in this system:

(1) internal exhaust surface
(2) nozzle flap
(3 + 4) internal centerbody surface
(5) visible centerbody surface
(6) turbine exit plane

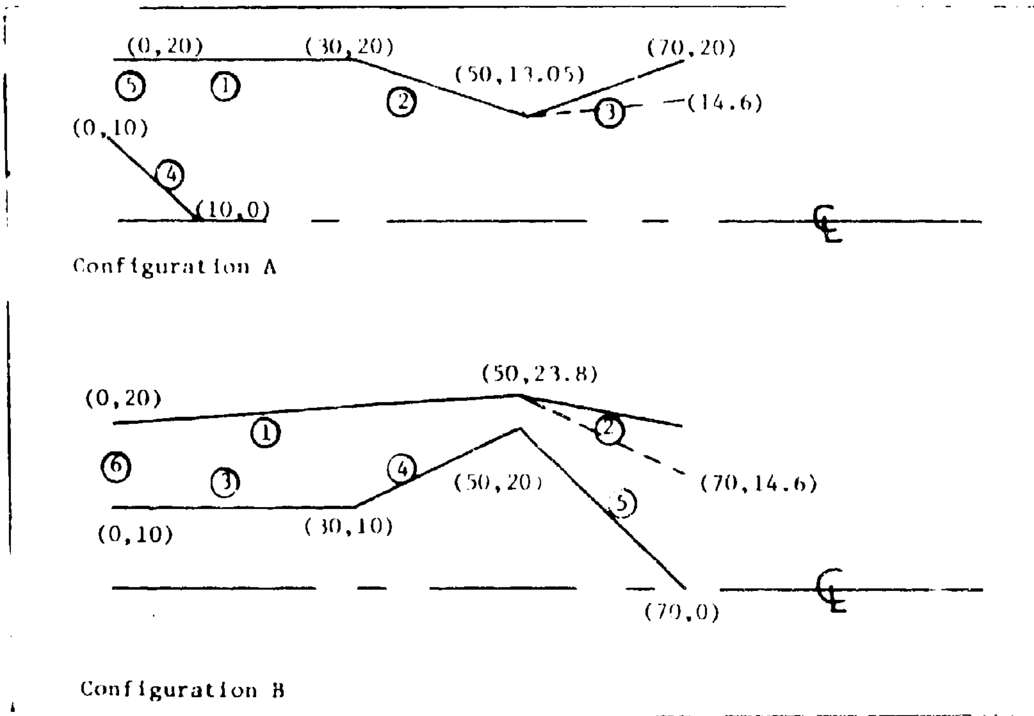

Figure 6. Schematics of Basic Exhaust Configurations.

Table 6. Schedule for Surface Temperatures and Emissivities for Suppressed Exhaust Configurations

Temperature (°R)/Emissivity

Surface No.	A - 0	A-1	A-2	A-3
1	2008/.65	→	→	→
2	1388/.65	→	→	→
3	1388/.65	→	1100/.65	1100/.65
4	2008/.55	1100/.65	→	1100/.95
5	2108/1.0	→	→	→
	B - 0	**B-1**	**B-2**	**B-3**
1	2008/.65	→	→	→
2	1388/.65	→	1100/.65	1100/.95
3-4	2008/.65	→	→	→
5	2008/.65	1100/.65	→	1100/.95
6	2108/.65	→		→

2. Input Instructions (For card listing see Figure 7)

a. Executor
Same as Test Problem II

b. General Input
Same as Test Problem IV

c. Missile Descriptions
Not input appliable

d. Hot Parts Suppression
The number of exhaust systems to be studied is 8.

For each configuration specify:

(1) The X-Y coordinates of the outer flowpath surface from the turbine exit plane to the exhaust plane. (X1, Y1)

(2) The X-Y coordinates of the centerbody from the turbine exit plane to the end of the centerbody. (XC, YC)

The nodes supplied in this manner will be numbered internally in sequence. An additional node will be added to represent the turbine exit plane. Temperatures (Tw) and emissivities (EMS) must be supplied for each of these nodes.

The $ENGINE namelist must be used 8 times (once for each configuration) and all the input must be supplied in full each time.

No other input applies.

3. Description of Output: The description of output for this problem is the same as that of problem II except for the exhaust hot parts output.

For this case the coordinates of the exhaust surface and the centerbody are printed out. The internal view factors calculated by the system are given for each node along with the area. One additional node representing the nozzle exit plane is printed out for completeness. The total of all the viewfactors for a node should equal one. The percent error is an indication of the accuracy of the calculation. The temperatures and visible projected areas are printed for each aspect angle specified in the input. In addition to the total hot parts emissions, a breakdown of the emissions by node is printed for each aspect angle and wavelength band.

This is provided by giving

(a) the direct emissions from each node that are visible to the observer

```
$CYCLE
T5=2008,T7=1388,AR=534.6,P8=56.82,
PAMB=14.7,TAMB=519,V19=0,XM=1,
P8=56.82,
ALT=0,FAR=.0108,END=99$
                    PIREP TEST PROBLEM  5
                    HOT PARTS  UPPRESSION II
$INPUT
ASP=0,30,
RANGE=0,50000,
NE=8$
$ENGINE
TW=2008,1388,1388,2008,2108,
EMS=.65,.65,.65,.65,1,
X1=0,30,50,70,
Y1=20,20,13.05,14.6,
XC=0,10,
YC=10,0$
$ENGINE
TW=2008,1388,1388,1100,2108,
X1=0,30,50,70,
Y1=20,20,13.05,14.6,
XC=0,10,
YC=10,0$
$ENGINE
TW=2008,1388,1100,1100,2108,
EMS=.65,.65,.65,.65,1,
X1=0,30,50,70,
Y1=20,20,13.05,14.6,
XC=0,10,
YC=10,0$
$ENGINE
TW=2008,1388,1100,1100,2108,
EMS=.65,.65,.95,.95,1,
X1=0,30,50,70,
Y1=20,20,13.05,14.6,
XC=0,10,
YC=10,0$
$ENGINE
TW=2008,1388,2008,2008,2008,2108,
EMS=5*.65,1,
X1=0,50,70,
Y1=20,23.8,14.6,
XC=0,30,50,70,
YC=10,10,20,0,
$
$ENGINE
TW=2008,1388,2008,2008,1100,2108,
EMS=5*.65,1,
X1=0,50,70,
Y1=20,23.8,14.6,
XC=0,30,50,70,
YC=10,10,20,0,
$
$ENGINE
TW=2008,1100,2008,2008,1100,2108,
EMS=5*.65,1,
X1=0,50,70,
Y1=20,23.8,14.6,
XC=0,30,50,70,
YC=10,10,20,0,
$
$ENGINE
TW=2008,1100,2008,2008,1100,2108,
EMS=.65,.95,.65,.65,.95,1,
X1=0,50,70,
Y1=20,23.8,14.6,
XC=0,30,50,70,
YC=10,10,20,0,
$
```

Figure 7. Listing of Input Cards for Test Problem 5.

(b) the reflected emissions from each node that are visible
(c) the total visible emissions from each node and
(d) the cumulative emissions which is the emissions initiated from the node and reaching the observer either directly or via reflections off other nodes is also given for each node.

The cumulative emissions will be reduced directly with the cooling of the given node. The reflections will be reduced by increasing the emissivity of the node although the direct emissions will be simultaneously increased.

Consider, for example, the output for case 1 reproduced in Table 2 for an aspect angle of 0° and wavelength band 1.8-2.7. Although node 1 is not visible (area = 0) the emissions from node 1 escaping to the observer is 289 watts/steradian. If this were the only emission to be considered, one might reduce the temperature of the node 1 or increase the emissivity of the node 4 to eliminate the source of emissions.

4. Discussion of Results: A summary of the emissions for the various configurations is presented in Table 5, page 21.

The detailed output from Configuration A-1 which corresponds to the base case is somewhat higher at tail-on (0° aspect) than the PCIR predictions because the hotter turbine is directly visible and this is not usually the case. At 30° aspect the nozzle flaps have already been cooled to 1388°R so the emissions are less than those obtained from the PCIR numbers. Each change in configuration A reduced the emissions but the results were still too high.

Configuration B is especially effective at tail-on because the turbine and hot surfaces are completely hidden from view by the colder plug surface. Reflections keep the 30° aspect from being reduced quite as effectively, but there is a definite improvement.

Configuration B-2 is selected for more detailed evaluation.

TEST PROBLEM 6 - Spectral Signatures and Lockon

Objective: To determine the spectral plume signature, the effect of plume attenuation on the hot parts emissions and to reassess lockon range.

1. Input Discussion: A specific engine configuration has been selected. It is now worthwhile to examine it in some detail and estimate the reduced vulnerability by looking at the lockon ranges and comparing these with the initial unsuppressed configuration results. Since our final model is only hot parts suppressed, aspect angles of 0°, 30° and 60° only will be evaluated. Ranges of 5K and 50K should adequately bracket the lockon range for this case.

2. Input Instructions: (For card listing see Figure 8)

a. Executor same as problems 2 through 5
b. General Input

Specify: (1) 2 lines of title
(2) aspect angles (ASP) (degrees)
(3) ranges (ft)
THTA and ASPI not applicable

```
$CYCLE
T5=2008,T7=1388,A8=534.6,P8=56.82,
PAMB=14.7,TAMB=519,V19=0,XM=1,
P8=56.82,
ALT=0,FAR=.0108,END=99$
                PIREP TEST PROBLEM  6
                SPECTRAL SIGNATURE AND LOCKON
$INPUT
ASP=0,30,60,
RANGE=5000,50000,
SPEC=1,NLOCK=2,
NE=1$
$ENGINI
TW=2008,1100,2008,2008,1100,2108,
EMS=5*.65,1,
X1=0,50,70,
Y1=20,23.8,14.6,
XC=0,20,30,70,
YC=10,10,20,0,
$
```

Figure 8. Listing of Input Cards for Test Problem 6

c. Missile Description

NLOCK = 2 to specify lockon calculatio s
SPEC = 2. to print spectral plume emissions

d. Hot Parts Suppression

Select engine configuration B-2 from previous case.

3. Description of Output (Appendix A-VI):

Page 1 - A table defining the atmospheric conditions through which the plume and atmosphere is attenuated has been added to the output. Otherwise it is identical to previous cases.

Page 3 - Irradiance and plume/atmosphere transmissivity is output as a function of wavelength. Note the "blue spike" CO_2 peak of 9.9676 watts/ster/micron at 4.8μ and the water vapor band from 2.08-2 4μm and the CO_2 band from 4.19-4.375μm.

4. Discuss of Results: A comparison of the lockon ranges for the unsuppressed engine configurations is given in Table 7. The lockon envelopes have been reduced to less than ½ the former range in most cases. Nevertheless the attempt at invulnerability has probably been successful. The minimum lockon range is about 1 mile and the maximum is 10 miles. To accurately assess the missile capability, an analysis needs to make a much more elaborate study including the kinematic boundaries and tracking rates of the missile.

Table 7: Comparison of Lockon Ranges for Suppressed and Unsuppressed Configurations

Missile Numbers Aspect Angle	Test Problem 2 Unsuppressed 1	 2	Test Problem 6 Suppressed 1	 2
0	30.5	116.2	8.2	39.5
30	28.7	111.3	18.5	56.4
60	22.7	86.9	9.5	34.6

The design engineer will normally have no use for the radiation spectral distributions. However, if they are desired they can be obtained.

The spectral distributions of plume emissions printed for 60° at the two ranges has been plotted in Figure 9. These results are not untypical of plume emissions. The CO_2 (3.9-4.8μm) emissions are completely absorbed in the band center leaving emissions on the wings only. The 4.18μm wing is commonly referred to as the blue spike and the 4.4-4.8μm wing, as the red spike. CO_2 emissions are normally much higher than water vapor emissions because of absorption in the atmosphere. The area between the solid line and the dashed line represents the amount of absorption between 5K and 50K feet.

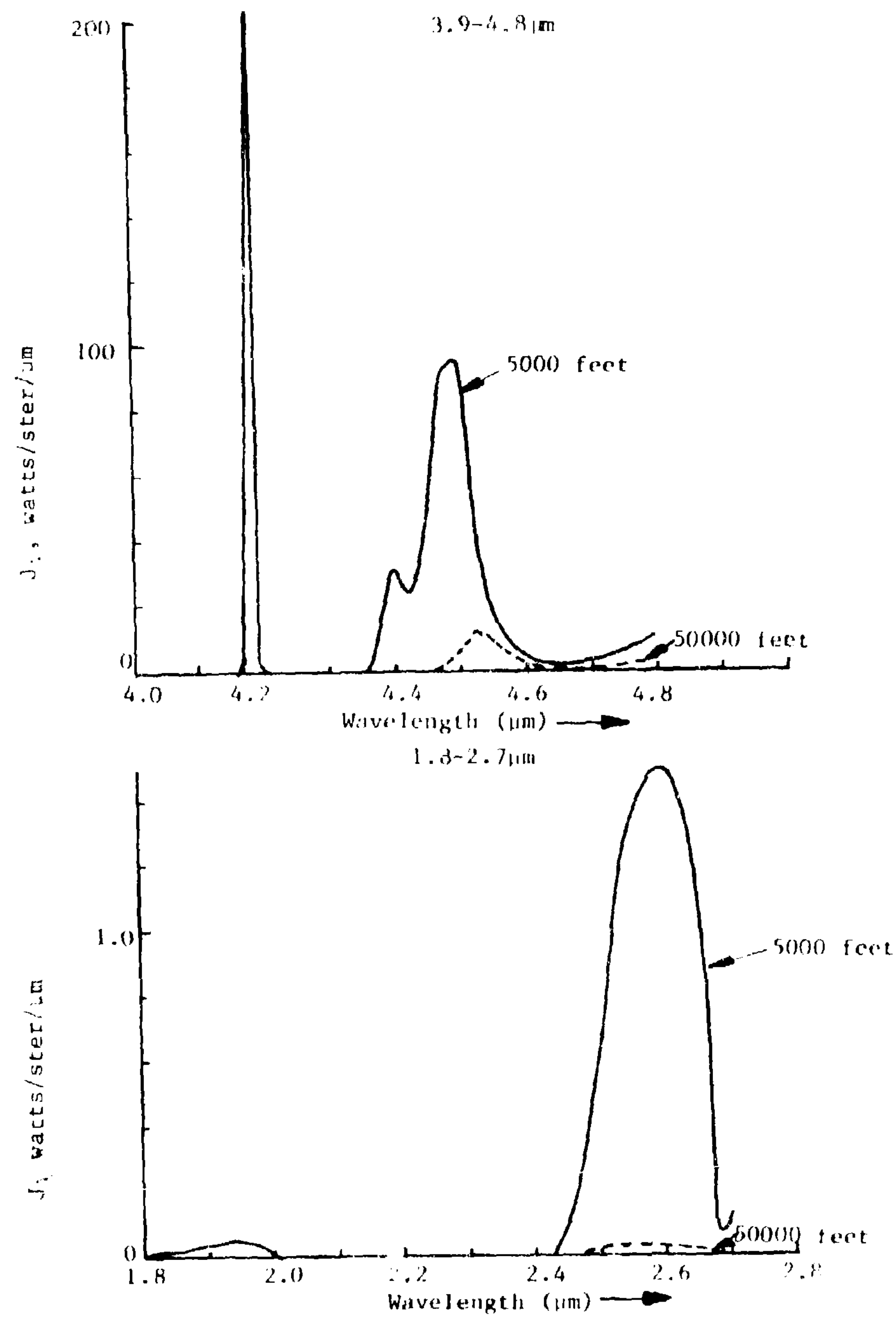

Figure 9 : Spectral Distribution of Plume Emission at 60° Aspect Angle, 5000 feet and 50000 feet.

TEST PROBLEM 7 - Missile Specifications with Airframe Emissions

Objective: To determine the lockon range of an installed engine for advanced missile threats.

1. Input Discussion: As plume/exhaust system signatures are more and more suppressed, the airframe itself or heated surface on the airframe may become a significant contributor to the IR, especially at nose-on aspects. For this problem, a surface has been heated to 1900°R and is observable at all aspect angles. The specific areas to be entered are 450, 300, and 210 at angles of 0, 30 and 170° respectively.

A specific missile of the future will probably not have as broad a wavelength band as those built into PIREP. A specific missile might be sensitive to radiation from the blue spike (4.17-4.25μm) or the red spike (4.4-4.6μm) in order to achieve a higher target to background contrast. These advanced missiles will have a much smaller noise equivalent input and be able to discriminate and lockon at a lower S/N ratio.

2. Input Instructions (For card input see figure 10)

   a. Executor Input
   Same as Test Problem II

   b. General Input
   Same as Test Problem II for 0, 30 and 170° only at 0, 5K and 50K feet

   c. Missile Description
   Specify AMI, AME the wavelength bands; SN, BSNS, NEI the characteristics of the two new missiles as given below.

Missile Number	(1)	(2)
Wavelength	4.6 to 4.25μm	4.4-4.6μm
Band Intensity	1.0	1.0
Signal-to-Noise Ratio	.7	.7
NEI (watts/in^2)	$.4 \times 10^{-10}$	$.4 \times 10^{-10}$

```
$CYCLE
T5=2008,T7=1388,A8=534.6,P8=56.82,
PAMB=14.7,TAMB=519,V19=0,XM=1,
P8=56.82,
ALT=0,FAR=.0108,END=99$
                PIREP TEST PROBLEM 7
                SPECTRAL SIGNATURE AND SPECIFIC MISSILES
$INPUT
ASP=0,30,170,
RANGE=0,5000,50000,
NLOCK=2,SN=.7,.7,
BSNS=1,1,NEI=4.E-11,4.E-11,
AMI=4.17,4.4,AME=4.25,4.6,
NE=1$
$ENGINE TM=1900,AR=750,500,350,EM=.6$
```

Figure 10: Listing of Input Cards for Test Problem 7.

d. Hot Parts Suppression: For this case, consider the original unsuppressed emissions in Case II for the internal system but add the hot surface temperature, TM, emissivity, EM, and missile areas, AR, for each of the angles specified on page 1 of the input.

3. Description of Output: The output format is the same as for Test Problem II except that there are 4 missiles. The missile numbers assigned on page 1 are those referred to on the last page with the lockon ranges even though the intermediate IR results are in a different sequence.

4. Discussion of Results: The particular advanced missiles defined in this problem are actually less of a threat than the basic missiles already considered. In actual practice, it is unlikely that one would be so lucky.

The addition of hot emissions in the nose-on aspect has dramtically increased the vulnerability to the threat from that direction. The temperature selected is much hotter than a normal airframe surface. In this case it represents a flange or extension of the exhaust system itself that operated as a plume shield from above but as an emitter from below and to the side.

It would be effective as a plume shield if the specific threat were only from the upper hemisphere, but not, as demonstrated here, if our air craft can be approached from below.

VIII. SUMMARY

Little knowledge in IR/countermeasures technology is necessary to use PIREP for comparing one engine/cycle against another for preliminary suppression evaluations. As a design engineer becomes more conversant with the problem involved, it is expected he will use more and more options available in the PIREP program and his knowledge and judgment will further increase.

Preliminary studies and evaluations will be made without reference to the IR expert. In this regard it is important to understand that PIREP provides preliminary estimates only. Before any final decision or commitment on achievable IR levels is made, a detailed study of the IR problem should be performed by more sophisticated techniques and more knowledgeable personnel. These studies, however, fall into the final selection phases and in no way diminish the importance of the preliminary evaluations.

PROGRAM DESCRIPTION

An overall flow chart depicting the subroutines used in PIREP is presented in Figure 11 following the general outline previously presented in Figure 1. Each of these subroutines and their function or purpose is listed in Table 8. A flow chart listing of each subroutine is presented in Appendix B.

The analysis of the various subroutines is presented either in the final report for this contract, Reference 2, or is available in Reference 2, which is the analysis volume of the SCORPIO IIIA computer program from which a number of these routines were extracted.

The parameters used in the subroutines newly developed for PIREP are defined in Table 9.

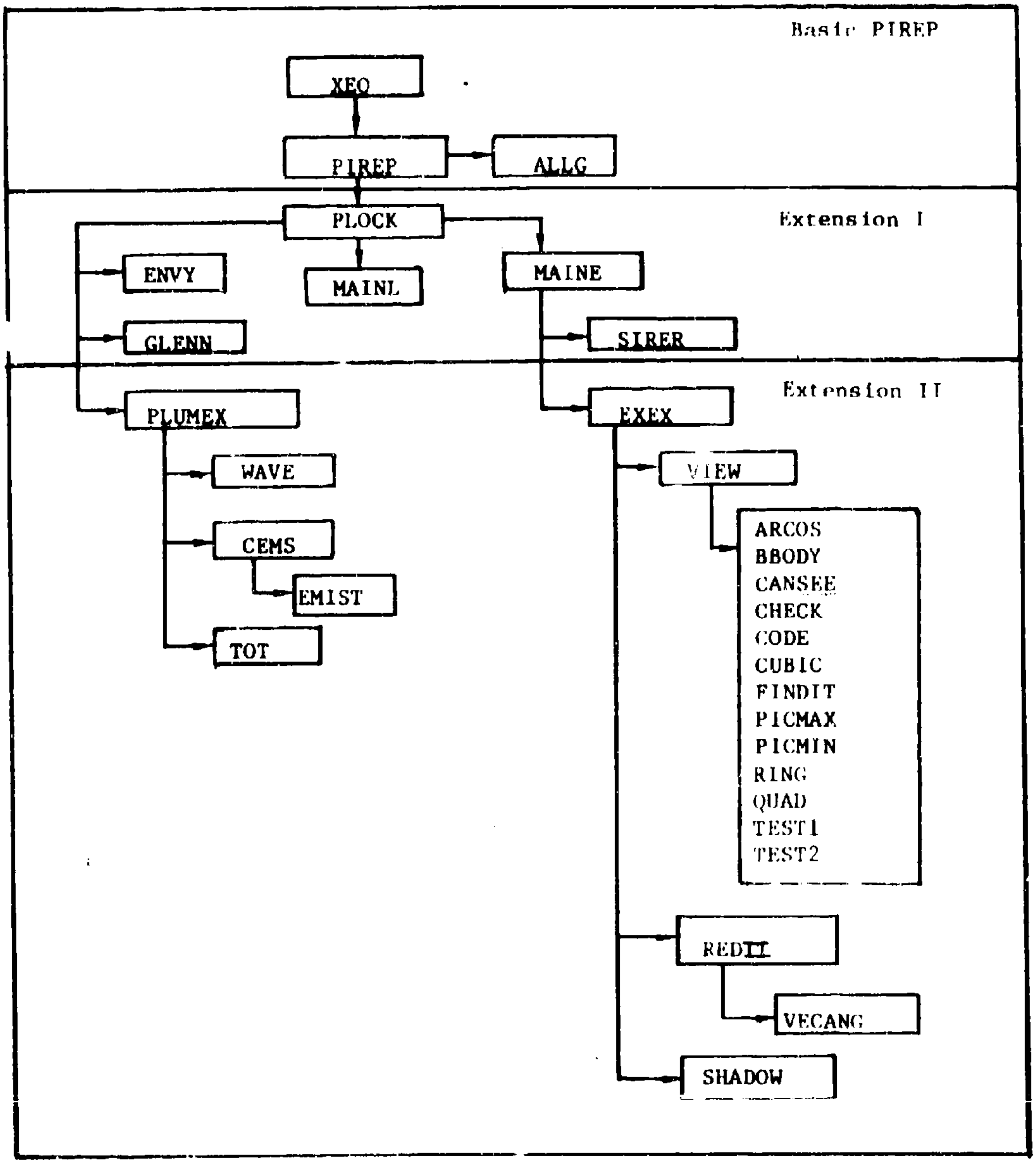

Figure 11: Flow Chart of PIREP Subroutines

TABLE 8: Listing of PIREP Subroutines and Their Functions

SUBROUTINE	PURPOSE	CALLED BY	EXTENSION	PAGE No.
ALLG	To test for zero argument before taking logarithm	PIREP	Basic	B6
ARCCOS	To calculate the angle in radians between 0 and $\pi/2$ for a given cosine value	VIEW	II	B138
BODY	To check whether the line of sight between points on two nodes is tangent to a shadowing body	BODY RING	II	B141
CANSEE	Checks the visibility between two nodes to determine if shadowing may occur	VIEW	II	B147
CEMS	Determine spectral gaseous emissions/transmission along a ray	PLUMEX	II	B63
CHECK	Checks the data routine in BODY for extraneous solutions	BODY	II	B154
CODE	Analyses results of FINDIT to describe the nature of shadowing between two nodes	VIEW	II	B157
CUBIC	Determine the real roots of a third order equation	BODY	II	B162
EMIST	Calculates transmissivity for a ray segment and accumulates band parameters	CEMS	II	B66
ENVY	Determines atmospheric conditions away from target	PLOCK	I	B53
EXEX	Controls flow of extension II hot parts suppression	MAINE	II	B91
FINDIT	Locates the axial positions of two nodes with respect to the axial positions of the configuration surfaces	VIEW	II	B174
GLENN	Determines the amount of plume suppression associated with the nozzle shaping and flight condition	PLOCK	I	B22

Table 8 (Cont'd)

SUBROUTINE	PURPOSE	CALLED BY	EXTENSION	PAGE NO.
MAINE	Reads engine input and relocates data for further calculations	PLOCK	I	B24
MAINL	Interpolates calculated signatures for lockon ranges	PLOCK	I	B39
PIREP	Calculates basic PCIR numbers	XEQ	Basic	B3
PLOCK	Controls all extension calculations	PIREP	I	B7
PICMAX	Determines maximum value of an array	VIEW	II	B176
PICMIN	Determines minimum value of an array	VIEW	II	B178
PLUMEX	Organizes data for plume spectral calculations	PLOCK VIEW	II	B43
QUAD	Determines the roots of a second order equation	CUBIC	II	B180
REDII	Computes and prints geometric view factors for a detector as a function of engine off-axis angle	EXEX	II	B194
RING	Determines the intersection of a shadowing body with the "cone of vision" that a point on one node sees of another node	VIEW	II	B183
SHADOW	Describes the surfaces used in VIEW in a manner compatible for RED II	EXEX	II	B190
SIRER	Computes internal radiation interchange factors and direct reflected and cumulative emissions for each surface	MAINE	I	B30
TEST 1	Tests the possibility of one node being shadowed by a second node which has the same axial location	VIEW	II	B186

Table 8 (Cont'd)

SUBROUTINE	PURPOSE	CALLED BY	EXTENSION	PAGE NO.
TEST 2	Determines whether a point lies between two other points	VIEW BODY CANSEE	II	B188
TOT	Integrates plume emissions and averages transmissivity over the specified wavelength bands	PLUMEX	II	B87
VECANG	Calculates the angle of a node relative to configuration centerline	REDII	II	B201
VIEW	Calculates and prints internal geometric view factors	EXEX	II	B96
WAVE	Determines the specific wavelengths for which calculations are to be made from the prescribed wavelength bands	PLUMEX	II	B59
XEQ	Executor Routine - Substitutes for cycle deck	---	Basic	B2

TABLE 10: PROGRAM PARAMETER DEFINITIONS

SYMBOL	DEFINITION	UNITS
A	Coefficient in equation for lockon interpolation	
A1	Coefficient for CO_2 line parameter strength	
A1, A2	Ray spectral correction factors adjusting to PCIR totals for each aspect angle	
A8	Throat Area	in^2
A9	Exit Area	in^2
A9Q8	A9/A8	
AA(10)	Dummy storage location	
AE(20) AI(20)	Wavelength intervals corresponding to the value of wavelength just beyond the band limit for the end and the beginning respectively of each band.	Microns
AI	Ray Emissions	watts/ster/ster.
AL(9)	Integrated absorption coefficients for H_2O	
AL	Altitudes in thousands of feet at which atmosphere changes characteristics. Defines altitude intervals	
AL	Wavelength interpolation factor for transmissivity	
AL1,AL2	Ray spectral correction factors adjusted to PCIR totals	
ALT,ALT1	Altitude	K Feet
AM	Wavelength	Microns
AME	Final Wavelength for each band interval	Microns
AMF	Final Wavelength	Microns
AMI	Initial wavelength of each band interval	Microns
AMO	First wavelength to be computed	Microns

TABLE 10 (CONT'D)

SYMBOL	DEFINITION	UNITS
AMR	Visible distance	Feet
AMX	Final wavelength	Microns
AMX	Just less than final wavelength	Microns
AN, AN1	Wave number	cm^{-1}
AN	Wave number	cm^{-1}
ANC	Fundamental vibrations for CO_2	cm
ANC	Number of increments for which atmospheric values are to be tabulated	
ANEI	Noise equivalent for reference missiles	cm^2
ANG	Current aspect angle	Degrees
ANO	Band centers for CO_2	cm^{-1}
ANU	Fundamental vibrations for H_2O	cm^{-1}
AP	Integrated absorption coefficients for CO_2	
AP	Projected areas	in^2
AR	Projected area of hot parts internal to exhaust system for each aspect angle	in^2
AREA	Area of exhaust system node surfaces	in^2
AQ	Determines whether wave number is above or below band center	
AQ	Sign of altitude differences	
ASP	Aspect angle from exhaust system centerline	Degrees
ASPI	Aspect ratios for rectangular exhaust shapes	
AT	Temperature difference for given altitude interval	°R
ATMS	Number of atmosphere segments in ray table	

TABLE 10 (CONT'D)

SYMBOL	DEFINITION	UNITS
ATOT	Total attenuated IR emissions for specified range	Watts/Sr.
ATST	Angle of diagonal for rectangular shaped exhaust	Degrees
AX,AXI	Current aspect ratio for rectangular exhahst shape	
B	Fundamental temperature - vibration factor	
B	Coefficient in equation for lockon calculation	
BB	Dummy storage	
BBEP	Black body emissive power	W/Sr.
BE	Molecular function for CO_2	
BI	Blackbody emissive power	Watts/Sr.
BL	Temperature factor for determining saturation concentration	
BL	Integrated absorption coefficients for CO, N_2O, and N_2	
BNU	Band centers for CO, N_2O and N_2	cm^{-1}
BSNS	Missile band sensitivity	
BTS	= 999. indicates no data has been supplied	
BUF4	Location of radiances to be integrated over wavelength bands	
BUF1	List of wavelengths for which correlations were made	Microns
BX,BZ	Molecular functions for CO, N_2O, and N_2	
C	Coefficient in equation for lockon calculation	
C1,C2	Constants in Planck's blackbody equation	
CA,CB	Temporary storage during graybody totalling	

TABLE 10 (CONT'D)

CASE	Number assigned internally to each different calculation set	
CDR	Conversion factor from radians to degrees	
CE(20), CI(20)	Wavelength intervals corresponding to the value of wavelength just inside the band limit for the end and beginning respectively of each band	
CIR1,CIR2	Hot parts cycle IR numbers	Watts/Sr.
CS	Cosine of aspect angle	
CX	Temporary storage location	
D	Log of (range + 250 feet)	
DA	Distance or range entries in atmospheric table	Feet
DAN	Wavenumber difference	cm^{-1}
DDM	Wavelength difference	Microns
DEL (2)	Wavelength increment used in graybody emission totalling	Microns
DH	Increment in altitude	K feet
DH	Location of CO_2 band head from band center	cm^{-1}
DL	Correction factor for CO_2 degeneracy	
DLL	Wavelength increment	Microns
DM	Wavelength interval associated with the given wavelength	Microns
DMN	Lockon range for each missile and aspect angle	Feet
DNX,DNY	Distance fr and center for equivalent symmetric mode	cm^{-1}
DNU	Distance from band center	cm^{-1}
DST	Range + 250 feet	Feet

TABLE 10 (CONT'D)

DXX	Plume core segment of ray	Feet
DZ1	Saved value of DNU	cm^{-1}
E	Emissivity	
EM	External Surface emissivity	
EMS	Exhaust Surface emissivity	
END,ENDA	Parameter to signal end or continuation of calculation	
EPS	A small quantity (0.00001)	
EXF	External flow plume suppression factor	
F	Proportion of initial altitude interval to be calculated	
F	View factors between exhaust system node surfaces	
F	Plume suppression factors: F(1) Broad/Round 1.8-2.7 F(2) Broad/Round 3.9-4.8 F(3) Narrow/Broad 1.8-2.7 F(4) Narrow/Broad 3.9-4.8	
F1,F2	Plume suppression factors	
F9	Ratio of A9/A8	
FAR,FAR8	Fuel-to-air ratio	
FE	Projected area	in^2
FIRST	Indicates initial calculation for specific engine configuration	
FS,FX	Temperature dependent effects for partially over-lapped lines	
FX	Angle pattern factor for hot parts	
FXF	External flow plume suppression factor	

TABLE 10 (CONT'D)

G	Planck's spectral blackbody function	
GD,GDD	Natural p s collision halfwidth functions	
GNU	H_2O Band centers	cm^{-1}
GX	Constant $\pi/10$	
H	Current altitude for table	K feet
HC2,HDH, HRA,HRX	Empirical functions for H_2O	
HSG,HSX	H_2O integrated line parameters	
HPTOT	Hot parts source emissions	Watts/Str
HTOT	Hot parts attenuated emissions	Watts/Str.
IA,IAA	Counts current aspect angle	
IE	Counts current exhaust configuration	
IR	Counts the number of range being calculated	
ISURF	Surface number	
IT	Counts elevation angle being calculated	
IX	Counts aspect ratio being calculated	
K	Locates totals in BUFFER4	
K	Locates interval in XST table	
LA	Order of missile characteristics related to wavelength bands after sequencing	
LK	Determines whether a new step size interval is being encountered	
M	Locates initial band wavelength in AMI table band	
M	Locates storage for totals	

TABLE 10 (CONT'D)

MC1,MC2	Limits for CO_2 calculation loop
MDM	Determines whether step sizes are to be larger or smaller than suggested values
MH1,MH2	Limits for H_2O calculation loop
MO	Locates end of original buffer storage
MX	Signals whether reference missile characteristics are to be used
N	Number of exhaust surfaces
N	Locates terminal band wavelength in AME table
N	Locates radiation per micron in buffer for each wavelength
N1,N2	Denotes whether PIREP wavelength bands are reentered with input bands
NAI	Number of wavelengths to be computed
NAS	Number of aspect angles to be calculated for hot parts
NB	Number of altitude intervals to be computed
NC1,NC2, NC3	H_2O vibration quantum numbers
NL	Counter in PL array
NLOCK	Signals whether locon calculations are to be made
NNN	Number of inlet + exit nodes
NNNN	Signals centerline node
NODE	Node number
NPG	Case number being calculated
NPRINT	Signal for atmospheric or plume spectral computation

TABLE 10 (CONT'D)

		UNITS
NSPEC	Number of wavelength intervals	
NSS	Number of missiles to be evaluated	
NTOT1	Total number of nodal surfaces in exhaust system	
NTR	Signals whether aspect ratio calculations are to be made	
NTT	Printout counter for spectral emissions	
NX	Number of wavelengths to be calculated spectrally	
NX1 NX2	Counters to properly printout spectral results	
NXY	Location of spectral emission in AA array	
NXX	Location of band totals in AA array	
P,PX,PSAV	Pressure	Atmos.
PB	Integrated pressure-path length	Atmos/Ft
PH,PHD	Halfwidth functions	
PS,PX	Temperature dependent function for calculation of partially overlapping line effects	
P8	Exhaust gas total pressure	psia
PA	Pressure entries in atmospheric table	atms.
P8QAMB	Exhaust gas total to ambient pressure ratio	
PA	Pressure entries in atmospheric table	atms
PAMB	Atmospheric pressure	psia
PC	Storage for adjusted PCIR, CIR numbers	Watts/Str.
PC1,PC2	Storage for reference plume emissions after adjustment for attenuation factors	Watts/Str.
PCIR1,PCIR2	Plume IR numbers	Watts/Str.

TABLE 10 (CONT'D)

PL	Saturation concentration as a function of ground level temperature from 443°R by increments of 10°R	
PR	$(P8/PA)^{0.25}$	
PTOT	Plume IR emissions for each wavelength band	Watts/Ster.
PV	Partial pressure for current input	
PX	Atmospheric transmissivity factor pressure entries in ray table	Atmos.
QS	Scattering function	
RANGE	Range to observer	Feet
RF	Radial coordinates of exhaust surface	in.
RG	(range + 250)/1000	
RH	Reflection coefficients	
RX1	Plume through atmosphere	
RX2	Transmission factors for reference wavelength bands	
S1	CO_2 optical depth	
S1-S7	Logarithms of PCIR variables	
SA	Aspect angle pattern factor	
SCS	Signal for computing wavelength dependent value of scattering	
SD, SG, SK, SDX, SXQ	Molecular functions for H_2O local line parameters	
SGH, SXH	CO_2 integrated line parameters	
SKIP	Initialization indicator for emissivity calculations	
SN	Missile signal-to-noise ratio for lockon	
SNR	Signal to noise ratio for reference missiles	

TABLE 10 (CONT'D)

SPEE	Signals whether spectral calculations are to be made	
SS	Sine of aspect angle	
SW	Storage location for current wavelength during graybody totalling	
T	Temperature entries in ray table	°R
T5	Turbine discharge temperature	°R
T7	Exhaust gas exit temperature	°R
TA	Temperature entries in atmospheric tables	°R
TAK	Transmissivity	
TAMB	Ambient temperature	°R
TB	Hot parts source tempe ature effect in H_2O band transmissivity test	
TB,TBX	Temperature ratio functions	
TEST	Calculation limit for each band	cm^{-1}
THA	Aspect Angles	Degrees
THTA	Elevation angles to be calculated	Degrees
THT	Current elevation angle	Degrees
TM	Temperature of hot parts external to exhaust system	°R
TR	Averaged transmissivity of hot parts through atmospheric or plume/atmosphere	
TS	Static temperature	°R
TSC,TSK	Scattering factors	
TW	Exhaust system surface temperatures	°R
U	Exponential fundamental vibration factor	
V19	Secondary flow velocity	ft./sec.

TABLE 10 (CONT'D)

VE	External flow velocity	ft/sec
VECT	Normal vector for exhaust system surfaces (+ is inward)	
VR	Visible range	(K,km)
W	Initial wavelengths of specified	Microns
WRA	Cumulative emissions for each node surface	W/S
WV	Specific wavelengths for spectral calculation	Microns
X1,X2	Axial coordinates of exhaust surface	In.
X1	Optical depth, H_2O	Feet
XC	Axial coordinates defining exhaust system centerbody	in.
XC	CO_2 concentration entries in ray table	
XH	Water vapor concentration entries in ray table	
XHA	Water vapor concentration entries in atmospheric table	
XM	Flight Mach number	
XRC,XRH	CO_2, H_2O concentration in core stream	
XS	Segment length entries in ray table	
XST	Wavelength demarkation for changes in step size	Microns
XX	Storage area for suppression factors (F(1)-F(4))	
Y1,Y2	Radial coordinates of exhaust surface	In.
Y1	Portion of exit area associated with TW(1)	
YC	Radial coordinates defining exhaust system centerbody	In.
YF	Axial coordinates of exhaust system	in.
Z	Transmissivity	
ZT	Temperature factor	

REFERENCES

1. Draft PIREP Final Report (to be Published)

2. Wilton, M.E., "Spectral Calculation of Infrared Radiation from a Turbine Propulsion System as Intercepted by an Observer - Volume II - Analysis", General Electric Company R73AEG322, September 1973.

APPENDIX A

OUTPUT FOR TEST PROBLEMS

CASE NO. 1.0

T7	1415.00	T5	1992.00
P8	42.53	A8	511.30
PAMB	14.70	XM	0.
VC19	0.		

IR INDICES

	1.8-2.7	3.9-4.8
PLUME	20.	299.
HOT PTS	1836.	1211.

CASE NO. 2.0

T7	1388.00	T5	2008.00
P8	56.82	A8	534.60
PAMB	14.70	XM	1.00
VC19	0.		

IR INDICES

	1.8-2.7	3.9-4.8
PLUME	17.	349.
HOT PTS	2010.	1298.

CASE NO. 3.0

T7	1402.00	T5	2031.00
P8	20.64	A8	529.80
PAMB	1.68	XM	2.00
VC19	0.		

IR INDICES

	1.8-2.7	3.9-4.8
PLUME	1.	107.
HOT PTS	2127.	1334.

CASE NO. 4.0

T7	1992.00	T5	1992.00
P8	42.70	A8	320.70
PAMB	14.70	XM	0.
VC19	1540.70		

IR INDICES

	1.8-2.7	3.9-4.8
PLUME	205.	10[illegible]8.
HOT PTS	1151.	739.

CASE NO. 5.0

T7	2008.00	T5	2008.00
P8	55.36	A8	311.90
PAMB	14.70	XM	1.00
VC19	1805.70		

IR INDICES

	1.8-2.7	3.9-4.8
PLUME	241.	1410.
HOT PTS	1173.	757.

CASE NO. 6.0

T7	2031.00	T5	2031.00
P8	19.77	A8	298.10
PAMB	1.68	XM	2.00
VC19	2353.10		

IR INDICES

	1.8-2.7	3.9-4.8
PLUME	17.	671.
HOT PTS	1197.	750.

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 1

** PIREP OUTPUT **

T7	1388.00	TS	2008.00
P8	56.82	A8	534.60
PAMB	14.70	XM	1.00
VC19	0.	ALT	0.
FAR	0.01		

IR INDICES

	1.8-2.7	3.9-4.8
PLUME	17.	349.
HOT PTS	2010.	1298.

* * * * * * * * * * * * * * * * * * * *

MISSILE PARAMETERS

* * * * * * * * * * * * * * * * * * * *

NO.	WAVELENGTH BAND (MICRONS)	SENSITIVITY	NEI (WATTS/CM**2)	S/N
1	1.80 -.700	1.0	0.2000E-09	3.0
2	3.90 -.800	1.0	0.4000E-10	0.7

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 1

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET

```
EXHAUST HOT PARTS [illegible]
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

 NODE   TEMPERATURE          PROJECTED AREAS (FT 2) AT EACH ASPECT ANGLE
NUMBER      (F)            0.        30.0      60.0

  1      2008.0          530.6    463.0    267.3
                         * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

        ASP =     0.  DEGREES,      WAVELENGTH BAND   1.8 - 2.7     TOTAL EMISSIONS =   2010.13

        ASP =     0.  DEGREES,      WAVELENGTH BAND   3.9 - 4.8     TOTAL EMISSIONS =   1298.23

        ASP =    30.00DEGREES,      WAVELENGTH BAND   1.8 - 2.7     TOTAL EMISSIONS =   1740.83

        ASP =    30.00DEGREES,      WAVELENGTH BAND   3.9 - 4.8     TOTAL EMISSIONS =   1124.30

        ASP =    60.00DEGREES,      WAVELENGTH BAND   1.8 - 2.7     TOTAL EMISSIONS =   1005.07

        ASP =    60.00DEGREES,      WAVELENGTH BAND   3.9 - 4.8     TOTAL EMISSIONS =    649.12

    PLUME IR TOTALS

            FROM 1.80 TO 2.70  MICRONS =       1.4492  WT/ST
            FROM 3.90 TO 4.80  MICRONS =      30.4436  WT/ST

    ATTENUATED HOT PARTS IR TOTALS

            FROM 1.80 TO 2.70  MICRONS =    2010.1341  WT/ST
            FROM 3.90 TO 4.80  MICRONS =    1298.2283  WT/ST
```

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 2

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 5000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0237 WT/ST
FROM 3.90 TO 4.80 MICRONS = 1.2522 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 827.6779 WT/ST
FROM 3.90 TO 4.80 MICRONS = 663.7175 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 3

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0031 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.1129 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 424.2439 WT/ST
FROM 3.90 TO 4.80 MICRONS = 424.5750 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 4

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 100000.00 FEET

PLUME IR TOTALS

FROM	1.80	TO	2.70	MICRONS =	0.0026	WT/ST
FROM	3.90	TO	4.80	MICRONS =	0.0741	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM	1.80	TO	2.70	MICRONS =	302.7981	WT/ST
FROM	3.90	TO	4.80	MICRONS =	352.5859	WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 5

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM	1.80	TO	2.70	MICRONS =	8.3138	WT/ST
FROM	3.90	TO	4.80	MICRONS =	174.6505	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM	1.80	TO	2.70	MICRONS =	1740.8292	WT/ST
FROM	3.90	TO	4.80	MICRONS =	1124.3000	WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 6

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 5000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.1361 WT/ST
FROM 3.90 TO 4.80 MICRONS = 7.1839 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 716.7909 WT/ST
FROM 3.90 TO 4.80 MICRONS = 574.7969 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 7

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0176 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.6479 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 367.4064 WT/ST
FROM 3.90 TO 4.80 MICRONS = 367.6932 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 9

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 60.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 14.3999 WT/ST
FROM 3.90 TO 4.80 MICRONS = 302.5041 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1005.0741 WT/ST
FROM 3.90 TO 4.80 MICRONS = 649.1187 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 8

PIREP EXTENSION STUDY

E EVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 100000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0151 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.4251 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 262.2312 WT/ST
FROM 3.90 TO 4.80 MICRONS = 305.3487 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 10

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 60.00 DEGREES
RANGE = 5000.00 FEET

PLUME IR TOTALS

FROM 1.80	TO 2.70	MICRONS =	0.2358	WT/ST
FROM 3.90	TO 4.80	MICRONS =	12.4428	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80	TO 2.70	MICRONS =	413.8419	WT/ST
FROM 3.90	TO 4.80	MICRONS =	331.8611	WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 11

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 60.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80	TO 2.70	MICRONS =	0.0305	WT/ST
FROM 3.90	TO 4.80	MICRONS =	1.1222	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80	TO 2.70	MICRONS =	212.1234	WT/ST
FROM 3.90	TO 4.80	MICRONS =	212.2890	WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 12

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 60.00 DEGREES
RANGE = 100000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0262 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.7363 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 151.4001 WT/ST
FROM 3.90 TO 4.80 MICRONS = 176.2942 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 13

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 16.6276 WT/ST
FROM 3.90 TO 4.80 MICRONS = 349.3025 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 14

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 5000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.2723 WT/ST
FROM 3.90 TO 4.80 MICRONS = 14.3678 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 15

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0352 WT/ST
FROM 3.90 TO 4.80 MICRONS = 1.2958 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 17

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 130.00 DEGREES
RANGE = 0. EET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 12.7374 WT/ST
FROM 3.90 TO 4.80 MICRONS = 267.5805 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 16

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 100000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0303 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.8502 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 18

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 130.00 DEGREES
RANGE = 5000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.2086 WT/ST
FROM 3.90 TO 4.80 MICRONS = 11.0063 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 19

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 130.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0270 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.9926 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 20

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 130.00 DEGREES
RANGE = 100000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0232 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.6513 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 21

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 170.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 2.8873 WT/ST
FROM 3.90 TO 4.80 MICRONS = 60.6555 WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 22

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 170.00 DEGREES
RANGE = 5000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS =	0.0473	WT/ST
FROM 3.90 TO 4.80 MICRONS =	2.4949	WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 23

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 170.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS =	0.0061	WT/ST
FROM 3.90 TO 4.80 MICRONS =	0.2250	WT/ST

PIREP TEST PROBLEM 2
SIGNATURE AND LOCKON

CASE 24

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 170.00 DEGREES
RANGE = 100000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0053 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.1476 WT/ST

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LOCKON RANGE, FEET

* * * * * * * * * * * * * * * * * * * *

ASPECT ANGLE (DEG)	MISSILE NUMBER 1	2
0.	30508.	118[illegible]04.
30.00	28709.	111251.
60.00	22720.	86837.
90.00	2299.	12930.
130.00	2210.	11878.
170.00	1836.	7530.

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 1

** PIREP OUTPUT **

T7	1388.00	T5	2008.00
P8	56.82	A8	534.60
PAMB	14.70	XM	1.00
VC19	0.	ALT	0.
FAR	0.01		

IR INDICES

	1.8-2.7	3.9-4.8
PLUME	17.	349.
HOT PTS	2010.	1298.

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MISSILE PARAMETERS

* * * * * * * * * * * * * * * * * * * *

NO.	WAVELENGTH BAND (MICRONS)	SENSITIVITY	NEI (WATTS/CM**2)	S/N
1	1.80 -.700	0.5	0.2000E-09	5.0
2	3.90 -.800	0.7	0.4000E-10	0.7

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 1

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 16.6276 WT/ST
FROM 3.90 TO 4.80 MICRONS = 349.3025 WT/ST

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 2

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0352 WT/ST
FROM 3.90 TO 4.80 MICRONS = 1.2958 WT/ST

* *

LOCKON RANGE, FEET

* *

ASPECT ANGLE (DEG)	MISSILE NUMBER 1	2
90.00	1413.	12372.

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 3

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 4.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.5956 WT/ST
FROM 3.90 TO 4.80 MICRONS = 167.0830 WT/ST

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 4

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 4.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0140 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.6198 WT/ST

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LOCKON RANGE, FEET

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ASPECT ANGLE (DEG)	MISSILE NUMBER 1	2
90.00	1055.	9719.

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 5

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 10.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 2.3279 WT/ST
FROM 3.90 TO 4.80 MICRONS = 95.3596 WT/ST

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 6

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 10.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0049 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.3530 WT/ST

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LOCKON RANGE, FEET

* * * * * * * * * * * * * * * * * * * *

ASPECT ANGLE (DEG)	MISSILE NUMBER 1	2
90.00	759.	8089.

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 7

PIREP EXTENSION STUDY

ELEVATION ANGLE= 45.0 DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 16.6276 WT/ST
FROM 3.90 TO 4.80 MICRONS = 349.3025 WT/ST

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 8

PIREP EXTENSION STUDY

ELEVATION ANGLE= 45.0 DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0352 WT/ST
FROM 3.90 TO 4.80 MICRONS = 1.2958 WT/ST

* *

LOCKON RANGE, FEET

* *

ASPECT ANGLE (DEG)	MISSILE NUMBER 1	2
90.00	1413.	12372.

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 9

PIREP EXTENSION STUDY

ELEVATION ANGLE= 45.0 DEGREES
ASPECT RATIO = 4.00
ASPECT ANGLE = 90.0 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 5.7456 WT/ST
FROM 3.90 TO 4.80 MICRONS = 151.7494 WT/ST

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 10

PIREP EXTENSION STUDY

ELEVATION ANGLE= 45.0 DEGREES
ASPECT RATIO = 4.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0122 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.5629 WT/ST

* *

LOCKON RANGE, FEET

* *

ASPECT ANGLE (DEG)	MISSILE NUMBER 1	2
90.00	10 0.	9417.

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 11

PIREP EXTENSION STUDY

ELEVATION ANGLE= 45.0 DEGREES
ASPECT RATIO = 10.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80	TO 2.70	MICRONS	=	1.7960	WT/ST
FROM 3.90	TO 4.80	MICRONS	=	78.3223	WT/ST

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 12

PIREP EXTENSION STUDY

ELEVATION ANGLE= 45.0 DEGREES
ASPECT RATIO = 10.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80	TO 2.70	MICRONS	=	0.0038	WT/ST
FROM 3.90	TO 4.80	MICRONS	=	0.2906	WT/ST

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LOCKON RANGE, FEET

* * * * * * * * * * * * * * * * * * * *

ASPECT ANGLE (DEG)	MISSILE NUMBER 1	2
90.00	699.	7564.

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 13

PIREP EXTENSION STUDY

ELEVATION ANGLE= 90.0 DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 16.6276 WT/ST
FROM 3.90 TO 4.80 MICRONS = 349.3025 WT/ST

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 14

PIREP EXTENSION STUDY

ELEVATION ANGLE= 90.0 DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0352 WT/ST
FROM 3.90 TO 4.80 MICRONS = 1.2958 WT/ST

* *

LOCKON RANGE, FEET

* *

ASPECT ANGLE (DEG)	MISSILE NUMBER 1	2
90.00	1413.	12372.

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 15

PIREP EXTENSION STUDY

ELEVATION ANGLE= 90.0 DEGREES
ASPECT RATIO = 4.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 3.6936 WT/ST
FROM 3.90 TO 4.80 MICRONS = 114.7307 WT/ST

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 16

PIREP EXTENSION STUDY

ELEVATION ANGLE= 90.0 DEGREES
ASPECT RATIO = 4.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0078 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.4256 WT/ST

* *

LOCKON RANGE, FEET

* *

ASPECT ANGLE (DEG)	MISSILE NUMBER 1	2
90.00	878.	8594.

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 17

PIREP EXTENSION STUDY

ELEVATION ANGLE= 90.0 DEGREES
ASPECT RATIO = 10.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.5121 WT/ST
FROM 3.90 TO 4.80 MICRONS = 37.1906 WT/ST

PIREP TEST PROBLEM 3
PLUME SUPPRESSION

CASE 18

PIREP EXTENSION STUDY

ELEVATION ANGLE= 90.0 DEGREES
ASPECT RATIO = 10.00
ASPECT ANGLE = 90.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0011 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.1380 WT/ST

* *

LOCKON RANGE, FEET

* *

ASPECT ANGLE (DEG)	MISSILE NUMBER 1	2
90.00	470.	5944.

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I

CASE 1

** PIREP OUTPUT **

T7	1388.00	T5	2008.00
P8	56.82	A8	534.60
PAMB	14.70	XM	1.00
VC19	0.	ALT	0.
FAR	0.01		

IR INDICES

	1.8-2.7	3.9-4.8
PLUME	17.	349.
HOT PTS	2010.	1298.

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I

CASE 1

PIREP EXTENSION STUDY

ELEVATION ANGLE = 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET

EXHAUST HOT PARTS INPUT DATA

NODE NUMBER	TEMPERATURE (R)	PROJECTED AREAS (IN2) AT EACH ASPECT ANGLE 0.	30.0
1	1500.0	133.6	115.7
2	2008.0	401.0	347.2

NODE	AREA (SQ. INCHES),	DIRECT EMISSIONS	REFLECTED EMISSIONS (WATTS/STERADIAN)	RADIOSITY	CUMULATIVE EMISSIONS
ASP = 0. DEGREES,		WAVELENGTH BAND 1.8 - 2.7		TOTAL EMISSIONS =	1581.16
1	0.13365E 03	0.73903E 02	0.73410E-02	0.73911E 02	0.73911E 02
2	0.40095E 03	0.15076E 04	0.15077E 00	0.15078E 04	0.15078E 04
ASP = 0. DEGREES,		WAVELENGTH BAND 3.9 - 4.8		TOTAL EMISSIONS =	1087.84
1	0.13365E 03	0.11406E 03	0.11407E-01	0.11407E 03	0.11407E 03
2	0.40095E 03	0.97367E 03	0.97387E-01	0.97377E 03	0.97377E 03
ASP = 30.00DEGREES,		WAVELENGTH BAND 1.8 - 2.7		TOTAL EMISSIONS =	1369.33
1	0.11574E 03	0.63569E 02	0.63577E-02	0.63576E 02	0.63576E 02
2	0.34723E 03	0.13056E 04	0.13058E 00	0.13056E 04	0.13056E 04
ASP = 30.00DEGREES,		WAVELENGTH BAND 3.9 - 4.8		TOTAL EMISSIONS =	942.10
1	0.11574E 03	0.98777E 02	0.98791E-02	0.98786E 02	0.98786E 02
2	0.34723E 03	0.84322E 03	0.84335E-01	0.84331E 03	0.84331E 03

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1.4491 W/ST
FROM 3.90 TO 4.80 MICRONS = 30.4918 W/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1581.1612 W/ST
FROM 3.90 TO 4.80 MICRONS = 1087.8372 W/ST

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I

CASE 2

PIREP EXTENSION STUDY

ELEVATION ANGLE= [illegible]. DEGREES
ASPECT RATIO = 1.[illegible]
ASPECT ANGLE = [illegible]. DEGREES
RANGE = [illegible] FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = [illegible] WT/ST
FROM 3.90 TO 4.80 MICRONS = [illegible]29 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 333.2284 WT/ST
FROM 3.90 TO 4.80 MICRONS = 355.7683 WT/ST

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I

CASE 3

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 8.3132 WT/ST
FROM 3.90 TO 4.80 MICRONS = 174.6405 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1369.3280 WT/ST
FROM 3.90 TO 4.80 MICRONS = 942.0958 WT/ST

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I

CASE 4

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	0.0176	WT/ST
FROM 3.90 TO 4.80	MICRONS =	0.6479	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	288.5846	WT/ST
FROM 3.90 TO 4.80	MICRONS =	306.1048	WT/ST

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I

CASE 5

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET

```
                 EXHAUST HOT PARTS INPUT/OUTPUT
                 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

NODE  TEMPERATURE           PROJECTED AREAS (IN**2) AT EACH ASPECT ANGLE
NUMBER    (R)          0.      30.0

  1    1500.0       267.3   231.5
  2    2000.0       267.3   231.5
                 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *


               * * * * * * * * * * * * * * * * * * * * * *
NODE       AREA           DIRECT         REFLECTED       RADIOSITY      CUMULATIVE
                         EMISSIONS       EMISSIONS                      EMISSIONS
     (SQ.INCHES),              (WATTS/STERADIAN)

      ASP =    0.  DEGREES,      WAVELENGTH BAND   1.8 - 2.7      TOTAL EMISSIONS =   1151.99

   1    0.26730E 03    0.14681E 03    0.14683E-01    0.14682E 03    .14682E 03
   2    0.26730E 03    0.10051E 04    0.10052E 00    0.10052E 04    0.10052E 04

      ASP =    0.  DEGREES,      WAVELENGTH BAND   3.9 - 4.8      TOTAL EMISSIONS =    877.32

   1    0.26730E 03    0.22811E 03    0.22814E-01    0.22814E 03    0.22814E 03
   2    0.26730E 03    0.64911E 03    0.64919E-01    0.64918E 03    0.64918E 03

      ASP =   30.0DEGREES,      WAVELENGTH BAND   1.8 - 2.7      TOTAL EMISSIONS =    997.65

   1    0.23149E 03    0.12710E 03    0.12715E-01    0.12715E 03    0.12715E 03
   2    0.23149E 03    0.87041E 03    0.87051E-01    0.87050E 03    0.87050E 03

      ASP =   30.0DEGREES,      WAVELENGTH BAND   3.9 - 4.8      TOTAL EMISSIONS =    759.78

   1    0.23149E 03    0.19755E 03    0.19758E-01    0.19757E 03    0.19757E 03
   2    0.23149E 03    0.56215E 03    0.56221E-01    0.56221E 03    0.56221E 03

PLUME IR TOTALS

        FROM 1.80 TO 2.70  MICRONS =      1.0491  W/ST
        FROM 3.90 TO 4.80  MICRONS =     30.0416  W/ST

ATTENUATED HOT PARTS IR TOTALS

        FROM 1.80 TO 2.70  MICRONS =   1151.9987  W/ST
        FROM 3.90 TO 4.80  MICRONS =    877.3163  W/ST
```

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I

CASE 6

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	0.0031	WT/ST
FROM 3.90 TO 4.80	MICRONS =	0.1129	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	242.1330	WT/ST
FROM 3.90 TO 4.80	MICRONS =	286.9192	WT/ST

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I

CASE 7

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	8.3132	WT/ST
FROM 3.90 TO 4.80	MICRONS =	174.6405	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	997.6527	WT/ST
FROM 3.90 TO 4.80	MICRONS =	759.7791	WT/ST

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I
CASE 8

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0176 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.6479 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 209.6936 WT/ST
FROM 3.90 TO 4.80 MICRONS = 248.4796 WT/ST

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I
CASE 9

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET

```
                    EXHAUST HOT PARTS INPUT/OUTPUT
                    * * * * * * * * * * * * * * * * * * * * * * * * * * * *

   NODE  TEMPERATURE          PROJECTED AREAS (IN2) AT EACH ASPECT ANGLE
  NUMBER     (R)          0.      30.0

     1    1500.0        539.6   443.0
                    * * * * * * * * * * * * * * * * * * * * * * * * * * * *

         ASP =    0. DEGREES.     WAVELENGTH BAND   1.8 - 2.7     TOTAL EMISSIONS =   293.61

         ASP =    0. DEGREES.     WAVELENGTH BAND   3.9 - 4.8     TOTAL EMISSIONS =   456.23

         ASP =   30.00DEGREES.    WAVELENGTH BAND   1.8 - 2.7     TOTAL EMISSIONS =   254.28

         ASP =   30.00DEGREES.    WAVELENGTH BAND   3.9 - 4.8     TOTAL EMISSIONS =   395.11

  PLUME IR TOTALS

            FROM 1.80 TO 2.70  MICRONS =      1.4441  WT/ST
            FROM 3.96 TO 4.80  MICRONS =     30.4418  WT/ST

  ATTENUATED HOT PARTS IR TOTALS

            FROM 1.80 TO 2.70  MICRONS =    293.6130  WT/ST
            FROM 3.90 TO 4.80  MICRONS =    456.2249  WT/ST
```

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I

CASE 10

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	0.0031	WT/ST
FROM 3.90 TO 4.80	MICRONS =	0.1129	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	58.8667	WT/ST
FROM 3.90 TO 4.80	MICRONS =	149.2060	WT/ST

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I

CASE 11

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	8.3132	WT/ST
FROM 3.90 TO 4.80	MICRONS =	174.6405	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	254.2766	WT/ST
FROM 3.90 TO 4.80	MICRONS =	395.1063	WT/ST

PIREP TEST PROBLEM 4
HOT PARTS SUPPRESSION I

CASE 12

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0176 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.6479 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 50.9801 WT/ST
FROM 3.90 TO 4.80 MICRONS = 129.2163 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 1

** PIREP OUTPUT **

T7	1388.00	T5	2008.00
P8	56.82	A8	534.60
PAMB	14.70	XM	1.00
VC19	0.	ALT	0.
FAR	0.01		

IR INDICES

	1.8-2.7	3.9-4.8
PLUME	17.	349.
HOT PTS	2010.	1298.

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 1

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET

EXTENDED HOT PARTS GEOMETRY

EXHAUST SURFACE COORDINATES, IN.

0.	30.00	50.00	70.00
20.00	20.00	13.05	14.60

CENTERBODY COORDINATES,IN.

0.	10.00
10.00	0.

SYSTEM INTERNAL VIEW FACTORS

F(1, 1)= 0.50261	F(1, 1)= 0.50261
F(1, 2)= 0.20569	F(2, 1)= 0.35272
F(1, 3)= 0.02801	F(3, 1)= 0.06060
F(1, 4)= 0.08432	F(4, 1)= 0.71547
F(1, 5)= 0.18228	F(5, 1)= 0.72914
F(1, 6)= 0.01707	F(6, 1)= 0.09611
AREA(1)= 3769.91 SQ. IN.	
F(2, 1)= 0.35272	F(1, 2)= 0.20569
F(2, 2)= 0.41534	F(2, 2)= 0.41534
F(2, 3)= 0.11355	F(3, 2)= 0.14326
F(2, 4)= 0.03289	F(4, 2)= 0.16277
F(2, 5)= 0.07807	F(5, 2)= 0.18211
F(2, 6)= 0.02086	F(6, 2)= 0.06847
AREA(2)= 2198.40 SQ. IN.	
F(3, 1)= 0.06060	F(1, 3)= 0.02801
F(3, 2)= 0.14326	F(2, 3)= 0.11355
F(3, 3)= 0.50482	F(3, 3)= 0.50482
F(3, 4)= 0.00373	F(4, 3)= 0.01463
F(3, 5)= 0.01039	F(5, 3)= 0.01922
F(3, 6)= 0.31813	F(6, 3)= 0.82781
AREA(3)= 1702.51 SQ. IN.	
F(4, 1)= 0.71547	F(1, 4)= 0.08432
F(4, 2)= 0.16277	F(2, 4)= 0.03289
F(4, 3)= 0.01463	F(3, 4)= 0.00373
F(4, 4)= 0.	F(4, 4)= 0.
F(4, 5)= 0.07829	F(5, 4)= 0.03690
F(4, 6)= 0.02894	F(6, 4)= 0.01920
AREA(4)= 444.29 SQ. IN.	
F(5, 1)= 0.72914	F(1, 5)= 0.18228
F(5, 2)= 0.18211	F(2, 5)= 0.07807
F(5, 3)= 0.01922	F(3, 5)= 0.01039
F(5, 4)= 0.03690	F(4, 5)= 0.07829
F(5, 5)= 0.	F(5, 5)= 0.
F(5, 6)= 0.03411	F(6, 5)= 0.04801
AREA(5)= 942.48 SQ. IN.	
F(6, 1)= 0.09611	F(1, 6)= 0.01707
F(6, 2)= 0.06847	F(2, 6)= 0.02086
F(6, 3)= 0.82781	F(3, 6)= 0.31813
F(6, 4)= 0.01920	F(4, 6)= 0.02894
F(6, 5)= 0.04801	F(5, 6)= 0.03411
F(6, 6)= 0.	F(6, 6)= 0.
AREA(6)= 669.66 SQ. IN.	

EXHAUST HOT PARTS INPUT/OUTPUT

NODE NUMBER	TEMPERATURE (R)	PROJECTED AREAS (IN2) AT EACH ASPECT ANGLE 0.	30.0
1	2000.0	0.	176.0
2	1380.0	0.	76.6
3	1380.0	138.6	331.2
4	2000.0	313.0	0.
5	2100.0	216.8	0.

NODE	AREA (SQ.INCHES),	DIRECT EMISSIONS (WATTS/STERADIAN)	REFLECTED EMISSIONS	RADIOSITY	CUMULATIVE EMISSIONS
ASP = 0. DEGREES,		WAVELENGTH BAND 1.8 - 2.7			TOTAL EMISSIONS = 2237.31
1	0.	0.	0.	0.	0.26170E 03
2	0.	0.	0.	0.	0.78877E 01
3	0.13864E 03	0.27079E 02	0.30526E 02	0.57605E 02	0.33906E 02
4	0.31381E 03	0.76705E 03	0.34064E 03	0.11077E 04	0.77647E 03
5	0.21677E 03	0.10719E 04	0.63156E-01	0.10720E 04	0.11573E 04
ASP = 0. DEGREES,		WAVELENGTH BAND 3.9 - 4.8			TOTAL EMISSIONS = 1416.50
1	0.	0.	0.	0.	0.16901E 03
2	0.	0.	0.	0.	0.16148E 02
3	0.13864E 03	0.55439E 02	0.30397E 02	0.85836E 02	0.69416E 02
4	0.31381E 03	0.69540E 03	0.22351E 03	0.71891E 03	0.50148E 03
5	0.21677E 03	0.61171E 03	0.42305E-01	0.61175E 03	0.66044E 03
ASP = 30.00DEGREES,		WAVELENGTH BAND 1.8 - 2.7			TOTAL EMISSIONS = 839.23
1	0.17600E 03	0.43019E 03	0.19719E 03	0.62738E 03	0.60443E 03
2	0.76637E 02	0.14969E 02	0.59249E 02	0.74218E 02	0.26425E 02
3	0.33123E 03	0.64696E 02	0.72931E 02	0.13763E 03	0.80442E 02
4	0.	0.	0.	0.	0.22959E 02
5	0.	0.	0.	0.	0.10497E 03
ASP = 30.00DEGREES,		WAVELENGTH BAND 3.9 - 4.8			TOTAL EMISSIONS = 683.88
1	0.17600E 03	0.27783E 03	0.12810E 03	0.40593E 03	0.39035E 03
2	0.76637E 02	0.30645E 02	0.42231E 02	0.72876E 02	0.54100E 02
3	0.33123E 03	0.13245E 03	0.72623E 02	0.20507E 03	0.16469E 03
4	0.	0.	0.	0.	0.14828E 02
5	0.	0.	0.	0.	0.59903E 02

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1.4491 WT/ST
FROM 3.90 TO 4.80 MICRONS = 30.0818 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 2237.3072 WT/ST
FROM 3.90 TO 4.80 MICRONS = 1416.4951 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 2

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0031 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.1129 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 473.2798 WT/ST
FROM 3.90 TO 4.80 MICRONS = 463.2534 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 3

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 8.3132 WT/ST
FROM 3.90 TO 4.80 MICRONS = 174.6405 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 839.2278 WT/ST
FROM 3.90 TO 4.80 MICRONS = 683.8834 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 4

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.90 MICRONS = 0.0176 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.6479 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.90 MICRONS = 176.3745 WT/ST
FROM 3.90 TO 4.80 MICRONS = 223.6585 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 5

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET

EXTENDED HOT PARTS GEOMETRY

EXHAUST SURFACE COORDINATES, IN.

0.	30.00	50.00	70.00
20.00	20.00	13.05	14.60

CENTERBODY COORDINATES,IN./

0.	10.00
10.00	0.

SYSTEM INTERNAL VIEW FACTORS

F(1, 1)= 0.50261	F(1, 1)= 0.50261
F(1, 2)= 0.20569	F(2, 1)= 0.35272
F(1, 3)= 0.02801	F(3, 1)= 0.06060
F(1, 4)= 0.08432	F(4, 1)= 0.71547
F(1, 5)= 0.18228	F(5, 1)= 0.72914
F(1, 6)= 0.01707	F(6, 1)= 0.09611

AREA(1)= 3769.91 SQ. IN.

F(2, 1)= 0.35272	F(1, 2)= 0.20569
F(2, 2)= 0.41534	F(2, 2)= 0.41534
F(2, 3)= 0.11355	F(3, 2)= 0.14326
F(2, 4)= 0.03289	F(4, 2)= 0.16277
F(2, 5)= 0.07807	F(5, 2)= 0.18211
F(2, 6)= 0.02086	F(6, 2)= 0.06847

AREA(2)= 2198.40 SQ. IN.

F(3, 1)= 0.06060	F(1, 3)= 0.02801
F(3, 2)= 0.14326	F(2, 3)= 0.11355
F(3, 3)= 0.50482	F(3, 3)= 0.50482
F(3, 4)= 0.00373	F(4, 3)= 0.01463
F(3, 5)= 0.01039	F(5, 3)= 0.01922
F(3, 6)= 0.31813	F(6, 3)= 0.82781

AREA(3)= 1742.51 SQ. IN.

F(4, 1)= 0.71547	F(1, 4)= 0.08432
F(4, 2)= 0.16277	F(2, 4)= 0.03289
F(4, 3)= 0.01463	F(3, 4)= 0.00373
F(4, 4)= 0.	F(4, 4)= 0.
F(4, 5)= 0.07829	F(5, 4)= 0.03690
F(4, 6)= 0.02894	F(6, 4)= 0.01920

AREA(4)= 444.29 SQ. IN.

F(5, 1)= 0.72914	F(1, 5)= 0.18228
F(5, 2)= 0.18211	F(2, 5)= 0.07807
F(5, 3)= 0.01922	F(3, 5)= 0.01039
F(5, 4)= 0.03690	F(4, 5)= 0.07829
F(5, 5)= 0.	F(5, 5)= 0.
F(5, 6)= 0.03411	F(6, 5)= 0.04801

AREA(5)= 942.48 SQ. IN.

F(6, 1)= 0.09611	F(1, 6)= 0.01707
F(6, 2)= 0.06847	F(2, 6)= 0.02086
F(6, 3)= 0.82781	F(3, 6)= 0.31813
F(6, 4)= 0.01920	F(4, 6)= 0.02894
F(6, 5)= 0.04801	F(5, 6)= 0.03411
F(6, 6)= 0.	F(6, 6)= 0.

AREA(6)= 669.66 SQ. IN.

EXHAUST HOT PARTS [illegible]

NODE NUMBER	TEMPERATURE (R)	PROJECTED AREAS (IN2) AT EACH ASPECT ANGLE 0.	30.0
1	2605.0	0.	176.0
2	1384.6	0.	76.6
3	1300.0	132.6	331.2
4	1100.0	313.8	0.
5	2108.0	216.8	0.

NODE	AREA (SQ.INCHES),	DIRECT EMISSIONS (WATTS/STERADIAN)	REFLECTED EMISSIONS	RADIOSITY	CUMULATIVE EMISSIONS
ASP = 0. DEGREES,		WAVELENGTH BAND 1.8 - 2.7			TOTAL EMISSIONS = 1125.53
1	0.	0.	0.	0.	0.14705E 00
2	0.	0.	0.	0.	0.33199E-02
3	0.13864E 03	0.41656E 02	0.65989E-02	0.41663E 02	0.41659E 02
4	0.31381E 03	0.11762E 02	0.90255E-01	0.11860E 02	0.11762E 02
5	0.21677E 03	0.10719E 04	0.60776E-01	0.10720E 04	0.10720E 04
ASP = 0. DEGREES,		WAVELENGTH BAND 3.9 - 4.8			TOTAL EMISSIONS = 759.07
1	0.	0.	0.	0.	0.94969E-01
2	0.	0.	0.	0.	0.67967E-02
3	0.13864E 03	0.85282E 02	0.80032E-02	0.85290E 02	0.85287E 02
4	0.31381E 03	0.61971E 02	0.64888E-01	0.62036E 02	0.61971E 02
5	0.21677E 03	0.61171E 03	0.41229E-01	0.61175E 03	0.61171E 03
ASP = 30.00DEGREES,		WAVELENGTH BAND 1.8 - 2.7			TOTAL EMISSIONS = 784.39
1	0.17600E 03	0.66175E 03	0.59430E-01	0.66181E 03	0.66181E 03
2	0.76637E 02	0.23026E 02	0.14352E-01	0.23041E 02	0.23030E 02
3	0.33123E 03	0.99522E 02	0.15766E-01	0.99538E 02	0.99526E 02
4	0.	0.	0.	0.	0.69707E-04
5	0.	0.	0.	0.	0.20532E-01
ASP = 30.00DEGREES,		WAVELENGTH BAND 3.9 - 4.8			TOTAL EMISSIONS = 670.35
1	0.17600E 03	0.42739E 03	0.33307E-01	0.42743E 03	0.42743E 03
2	0.76637E 02	0.87142E 02	0.10798E-01	0.87152E 02	0.87149E 02
3	0.33123E 03	0.20375E 03	0.19121E-01	0.20377E 03	0.20376E 03
4	0.	0.	0.	0.	0.36720E-03
5	0.	0.	0.	0.	0.11716E-01

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1.4491 WT/ST
FROM 3.90 TO 4.80 MICRONS = 30.4410 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1125.5320 WT/ST
FROM 3.90 TO 4.80 MICRONS = 759.0747 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 6

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2. 0	MICRONS =	0.0031	WT/ST
FROM 3.90 TO 4.8(	MICRONS =	0.1129	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	238.3871	WT/ST
FROM 3.90 TO 4.80	MICRONS =	248.2492	WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 7

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	8.3132	WT/ST
FROM 3.90 TO 4.80	MICRONS =	174.6405	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	784.3929	WT/ST
FROM 3.90 TO 4.80	MICRONS =	678.3499	WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 8

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0176 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.6479 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 164.5011 WT/ST
FROM 3.90 TO 4.80 MICRONS = 221.8488 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 9

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET

EXTENDED HOT PARTS GEOMETRY

EXHAUST SURFACE COORDINATES, IN.

0.	30.00	50.00	70.00
20.00	20.00	13.05	14.60

CENTERBODY COORDINATES, IN./

0.	10.00
10.00	0.

SYSTEM INTERNAL VIEW FACTORS

```
F( 1, 1)= 0.50261          F( 1, 1)= 0.50261
F( 1, 2)= 0.20569          F( 2, 1)= 0.35272
F( 1, 3)= 0.02801          F( 3, 1)= 0.06060
F( 1, 4)= 0.08432          F( 4, 1)= 0.71547
F( 1, 5)= 0.18228          F( 5, 1)= 0.72914
F( 1, 6)= 0.01707          F( 6, 1)= 0.09611
          AREA( 1)= 3769.91 SQ. IN.

F( 2, 1)= 0.35272          F( 1, 2)= 0.20569
F( 2, 2)= 0.41534          F( 2, 2)= 0.41534
F( 2, 3)= 0.11355          F( 3, 2)= 0.14326
F( 2, 4)= 0.03289          F( 4, 2)= 0.16277
F( 2, 5)= 0.07807          F( 5, 2)= 0.18211
F( 2, 6)= 0.02086          F( 6, 2)= 0.06847
          AREA( 2)= 2198.40 SQ. IN.

F( 3, 1)= 0.06060          F( 1, 3)= 0.02801
F( 3, 2)= 0.14326          F( 2, 3)= 0.11355
F( 3, 3)= 0.50482          F( 3, 3)= 0.50482
F( 3, 4)= 0.00373          F( 4, 3)= 0.01463
F( 3, 5)= 0.01039          F( 5, 3)= 0.01922
F( 3, 6)= 0.31813          F( 6, 3)= 0.82781
          AREA( 3)= 1742.51 SQ. IN.

F( 4, 1)= 0.71547          F( 1, 4)= 0.08432
F( 4, 2)= 0.16277          F( 2, 4)= 0.03289
F( 4, 3)= 0.01463          F( 3, 4)= 0.00373
F( 4, 4)= 0.               F( 4, 4)= 0.
F( 4, 5)= 0.07829          F( 5, 4)= 0.03690
F( 4, 6)= 0.02894          F( 6, 4)= 0.01920
          AREA( 4)=  444.29 SQ. IN.

F( 5, 1)= 0.72914          F( 1, 5)= 0.18228
F( 5, 2)= 0.18211          F( 2, 5)= 0.07807
F( 5, 3)= 0.01922          F( 3, 5)= 0.01039
F( 5, 4)= 0.03690          F( 4, 5)= 0.07829
F( 5, 5)= 0.               F( 5, 5)= 0.
F( 5, 6)= 0.03411          F( 6, 5)= 0.04801
          AREA( 5)=  942.48 SQ. IN.

F( 6, 1)= 0.09611          F( 1, 6)= 0.01707
F( 6, 2)= 0.06847          F( 2, 6)= 0.02086
F( 6, 3)= 0.82781          F( 3, 6)= 0.31813
F( 6, 4)= 0.01920          F( 4, 6)= 0.02894
F( 6, 5)= 0.04801          F( 5, 6)= 0.03411
F( 6, 6)= 0.               F( 6, 6)= 0.
          AREA( 6)=  669.66 SQ. IN.
```

EXHAUST HOT PARTS INPUT/OUTPUT

NODE NUMBER	TEMPERATURE (F)	PROJECTED AREAS (IN2) AT EACH ASPECT ANGLE 0.	30.0
1	2028.0	0.	176.0
2	1388.0	0.	76.6
3	1100.0	138.5	331.2
4	1100.0	313.8	0.
5	2100.0	216.8	0.

NODE	AREA (SQ.INCHES),	DIRECT EMISSIONS (WATTS/STERADIAN)	REFLECTED EMISSIONS	RADIOSITY	CUMULATIVE EMISSIONS

ASP = 0. DEGREES, WAVELENGTH BAND 1.8 - 2.7 TOTAL EMISSIONS = 1439.02

1	0.	0.	0.	0.	0.26179E 03
2	0.	0.	0.	0.	0.78945E 01
3	0.13864E 03	0.33779E 01	0.24195E 02	0.27573E 02	0.42299E 01
4	0.31381E 03	0.76459E 01	0.33179E 03	0.33944E 03	0.77398E 01
5	0.21677E 03	0.10719E 04	0.59387E-01	0.10720E 04	0.11574E 04

ASP = 0. DEGREES, WAVELENGTH BAND 3.9 - 4.8 TOTAL EMISSIONS = 908.75

1	0.	0.	0.	0.	0.16907E 03
2	0.	0.	0.	0.	0.16162E 02
3	0.13864E 03	0.17798E 02	0.21489E 02	0.39266E 02	0.22287E 02
4	0.31381E 03	0.40285E 02	0.21744E 03	0.25772E 03	0.40780E 02
5	0.21677E 03	0.61171E 03	0.39856E-01	0.61175E 03	0.66045E 03

ASP = 30.00DEGREES, WAVELENGTH BAND 1.8 - 2.7 TOTAL EMISSIONS = 746.37

1	0.17600E 03	0.43019E 03	0.18094E 03	0.61063E 03	0.60464E 03
2	0.76637E 02	0.14969E 02	0.54898E 02	0.69867E 02	0.26441E 02
3	0.33123E 03	0.80703E 01	0.57806E 02	0.65876E 02	0.10036E 02
4	0.	0.	0.	0.	0.22894E 00
5	0.	0.	0.	0.	0.10503E 03

ASP = 30.00DEGREES, WAVELENGTH BAND 3.9 - 4.8 TOTAL EMISSIONS = 5[illegible].65

1	0.17600E 03	0.27703E 03	0.11790E 03	0.39529E 03	0.39050E 03
2	0.76637E 02	0.30845E 02	0.38651E 02	0.69498E 02	0.54133E 02
3	0.33123E 03	0.42521E 02	0.51339E 02	0.93860E 02	0.52875E 02
4	0.	0.	0.	0.	0.12002E 01
5	0.	0.	0.	0.	0.59935E 02

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1.4491 WT/ST
FROM 3.90 TO 4.80 MICRONS = 30.4418 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1439.0193 WT/ST
FROM 3.90 TO 4.80 MICRONS = 908.7539 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 10

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0031 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.1129 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 304.8907 WT/ST
FROM 3.90 TO 4.80 MICRONS = 297.2006 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 11

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 8.3132 WT/ST
FROM 3.90 TO 4.80 MICRONS = 174.6405 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 746.3737 WT/ST
FROM 3.90 TO 4.80 MICRONS = 558.6503 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 12

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	0.0176	WT/ST
FROM 3.90 TO 4.80	MICRONS =	0.6479	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	157.3289	WT/ST
FROM 3.90 TO 4.80	MICRONS =	182.7020	WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 13

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET

EXTENDED HOT PARTS GEOMETRY

EXHAUST SURFACE COORDINATES, IN.

0.	30.00	50.00	70.00
20.00	20.00	13.05	14.60

CENTERBODY COORDINATES, IN.

0.	10.00
10.00	0.

SYSTEM INTERNAL VIEW FACTORS

```
F( 1, 1)= 0.50261          F( 1, 1)= 0.50261
F( 1, 2)= 0.20569          F( 2, 1)= 0.35272
F( 1, 3)= 0.02801          F( 3, 1)= 0.06060
F( 1, 4)= 0.08432          F( 4, 1)= 0.71547
F( 1, 5)= 0.18228          F( 5, 1)= 0.72914
F( 1, 6)= 0.01707          F( 6, 1)= 0.09611
          AREA( 1)=  769.91 SQ. IN.

F( 2, 1)= 0.35272          F( 1, 2)= 0.20569
F( 2, 2)= 0.41534          F( 2, 2)= 0.41534
F( 2, 3)= 0.11355          F( 3, 2)= 0.14326
F( 2, 4)= 0.03289          F( 4, 2)= 0.16277
F( 2, 5)= 0.07807          F( 5, 2)= 0.18211
F( 2, 6)= 0.02086          F( 6, 2)= 0.06847
          AREA( 2)= 2198.40 SQ. IN.

F( 3, 1)= 0.06060          F( 1, 3)= 0.02801
F( 3, 2)= 0.14326          F( 2, 3)= 0.11355
F( 3, 3)= 0.50482          F( 3, 3)= 0.50482
F( 3, 4)= 0.00373          F( 4, 3)= 0.01463
F( 3, 5)= 0.01039          F( 5, 3)= 0.01922
F( 3, 6)= 0.31813          F( 6, 3)= 0.82781
          AREA( 3)= 1742.51 SQ. IN.

F( 4, 1)= 0.71547          F( 1, 4)= 0.08432
F( 4, 2)= 0.16277          F( 2, 4)= 0.03289
F( 4, 3)= 0.01463          F( 3, 4)= 0.00373
F( 4, 4)= 0.               F( 4, 4)= 0.
F( 4, 5)= 0.07829          F( 5, 4)= 0.03690
F( 4, 6)= 0.02894          F( 6, 4)= 0.01920
          AREA( 4)=  444.29 SQ. IN.

F( 5, 1)= 0.72914          F( 1, 5)= 0.18228
F( 5, 2)= 0.18211          F( 2, 5)= 0.07807
F( 5, 3)= 0.01922          F( 3, 5)= 0.01039
F( 5, 4)= 0.03690          F( 4, 5)= 0.07829
F( 5, 5)= 0.               F( 5, 5)= 0.
F( 5, 6)= 0.03411          F( 6, 5)= 0.04801
          AREA( 5)=  982.48 SQ. IN.

F( 6, 1)= 0.09611          F( 1, 6)= 0.01707
F( 6, 2)= 0.06847          F( 2, 6)= 0.02086
F( 6, 3)= 0.82781          F( 3, 6)= 0.31813
F( 6, 4)= 0.01920          F( 4, 6)= 0.02894
F( 6, 5)= 0.04801          F( 5, 6)= 0.03411
F( 6, 6)= 0.               F( 6, 6)= 0.
          AREA( 6)=  669.[illegible] SQ. IN.
```

EXHAUST HOT PARTS INPUT/OUTPUT

* *

NODE NUMBER	TEMPERATURE (R)	PROJECTED AREAS (IN2) AT EACH ASPECT ANGLE 0.	30.0
1	2008.0	0.	176.0
2	1380.0	0.	76.6
3	1100.0	138.6	331.2
4	1100.0	313.8	0.
5	2108.0	216.8	0.

* *

* *

NODE	AREA (SQ.INCHES),	DIRECT EMISSIONS	REFLECTED EMISSIONS (WATTS/STERADIAN)	RADIOSITY	CUMULATIVE EMISSIONS
	ASP = 0. DEGREES,		WAVELENGTH BAND	1.8 - 2.7	TOTAL EMISSIONS = 1438.90
1	0.	0.	0.	0.	0.26170E 03
2	0.	0.	0.	0.	0.78877E 01
3	0.13868E 03	0.33779E 01	0.24081E 02	0.27459E 02	0.42295E 01
4	0.31381E 03	0.76459E 01	0.33179E 03	0.33943E 03	0.77398E 01
5	0.21677E 03	0.10719E 04	0.59387E-01	0.10720E 04	0.11573E 04
	ASP = 0. DEGREES,		WAVELENGTH BAND	3.9 - 4.8	TOTAL EMISSIONS = 908.67
1	0.	0.	0.	0.	0.16901E 03
2	0.	0.	0.	0.	0.16148E 02
3	0.13868E 03	0.17798E 02	0.21407E 02	0.39205E 02	0.22285E 02
4	0.31381E 03	0.40285E 02	0.21743E 03	0.25772E 03	0.40779E 02
5	0.21677E 03	0.61171E 03	0.39856E-01	0.61175E 03	0.66044E 03
	ASP = 30.00DEGREES,		WAVELENGTH BAND	1.8 - 2.7	TOTAL EMISSIONS = 746.09
1	0.17600E 03	0.43019E 03	0.18044E 03	0.61063E 03	0.60843E 03
2	0.76637E 02	0.14969E 02	0.54892E 02	0.69861E 02	0.26425E 02
3	0.33123E 03	0.80703E 01	0.57533E 02	0.65604E 02	0.10034E 02
4	0.	0.	0.	0.	0.22885E 00
5	0.	0.	0.	0.	0.10497E 03
	ASP = 30.00DEGREES,		WAVELENGTH BAND	3.9 - 4.8	TOTAL EMISSIONS = 558.44
1	0.17600E 03	0.27783E 03	0.11745E 03	0.39529E 03	0.39036E 03
2	0.76637E 02	0.30645E 02	0.38845E 02	0.69491E 02	0.54100E 02
3	0.33123E 03	0.42521E 02	0.51144E 02	0.93665E 02	0.52870E 02
4	0.	0.	0.	0.	0.12058E 01
5	0.	0.	0.	0.	0.59903E 02

PLUME IR TOTALS

FROM 1.80 TO 2.80 MICRONS = 1.8891 WT/ST
FROM 3.90 TO 4.80 MICRONS = 30.8418 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1438.9002 WT/ST
FROM 3.90 TO 4.80 MICRONS = 908.6671 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 14

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0031 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.1129 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 304.8656 WT/ST
FROM 3.90 TO 4.80 MICRONS = 297.1722 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 15

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 8.3132 WT/ST
FROM 3.90 TO 4.80 MICRONS = 174.6405 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 746.0902 WT/ST
FROM 3.90 TO 4.80 MICRONS = 558.4434 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 16

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0176 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.6479 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 157.2692 WT/ST
FROM 3.90 TO 4.80 MICRONS = 182.6344 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 17

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET

EXTENDED HOT PARTS GEOMETRY

EXHAUST SURFACE COORDINATES, IN.

0.	50.00	70.00
20.00	23.80	14.60

CENTERBODY COORDINATES, IN./

0.	30.00	50.00	70.00
10.00	10.00	20.00	0.

SYSTEM INTERNAL VIEW FACTORS

```
F( 1, 1)= 0.44018          F( 1, 1)= 0.44018
F( 1, 2)= 0.03966          F( 2, 1)= 0.10526
F( 1, 3)= 0.22935          F( 3, 1)= 0.85758
F( 1, 4)= 0.26879          F( 4, 1)= 0.89895
F( 1, 5)= 0.               F( 5, 1)= 0.
F( 1, 6)= 0.12645          F( 6, 1)= 0.83195
F( 1, 7)= 0.00473          F( 7, 1)= 0.04978
        AREA( 1)= 7048.19 SQ. IN.

F( 2, 1)= 0.10526          F( 1, 2)= 0.03966
F( 2, 2)= 0.21116          F( 2, 2)= 0.21116
F( 2, 3)= 0.00856          F( 3, 2)= 0.01206
F( 2, 4)= 0.02969          F( 4, 2)= 0.03742
F( 2, 5)= 0.47502          F( 5, 2)= 0.70986
F( 2, 6)= 0.01492          F( 6, 2)= 0.03699
F( 2, 7)= 0.11490          F( 7, 2)= 0.45568
        AREA( 2)= 2655.77 SQ. IN.

F( 3, 1)= 0.85758          F( 1, 3)= 0.22935
F( 3, 2)= 0.01206          F( 2, 3)= 0.00856
F( 3, 3)= 0.               F( 3, 3)= 0.
F( 3, 4)= 0.00981          F( 4, 3)= 0.00878
F( 3, 5)= 0.               F( 5, 3)= 0.
F( 3, 6)= 0.12331          F( 6, 3)= 0.21697
F( 3, 7)= 0.               F( 7, 3)= 0.
        AREA( 3)= 1884.96 SQ. IN.

F( 4, 1)= 0.89895          F( 1, 4)= 0.26879
F( 4, 2)= 0.03742          F( 2, 4)= 0.02969
F( 4, 3)= 0.00878          F( 3, 4)= 0.00981
F( 4, 4)= 0.               F( 4, 4)= 0.
F( 4, 5)= 0.               F( 5, 4)= 0.
F( 4, 6)= 0.03259          F( 6, 4)= 0.06410
F( 4, 7)= 0.               F( 7, 4)= 0.
        AREA( 4)= 2107.44 SQ. IN.

F( 5, 1)= 0.               F( 1, 5)= 0.
F( 5, 2)= 0.70986          F( 2, 5)= 0.47502
F( 5, 3)= 0.               F( 3, 5)= 0.
F( 5, 4)= 0.               F( 4, 5)= 0.
F( 5, 5)= 0.               F( 5, 5)= 0.
F( 5, 6)= 0.               F( 6, 5)= 0.
F( 5, 7)= 0.16628          F( 7, 5)= 0.44128
        AREA( 5)= 1777.15 SQ. IN.

F( 6, 1)= 0.83195          F( 1, 6)= 0.12645
F( 6, 2)= 0.03699          F( 2, 6)= 0.01492
F( 6, 3)= 0.21697          F( 3, 6)= 0.12331
F( 6, 4)= 0.06410          F( 4, 6)= 0.03259
F( 6, 5)= 0.               F( 5, 6)= 0.
F( 6, 6)= 0.               F( 6, 6)= 0.
F( 6, 7)= 0.               F( 7, 6)= 0.
        AREA( 6)= 1071.28 SQ. IN.

F( 7, 1)= 0.04978          F( 1, 7)= 0.00473
F( 7, 2)= 0.45568          F( 2, 7)= 0.11490
F( 7, 3)= 0.               F( 3, 7)= 0.
F( 7, 4)= 0.               F( 4, 7)= 0.
F( 7, 5)= 0.44128          F( 5, 7)= 0.16628
F( 7, 6)= 0.               F( 6, 7)= 0.
F( 7, 7)= 0.               F( 7, 7)= 0.
        AREA( 7)=  669.66 SQ. IN.
```

EXHAUST HOT PARTS INPUT/OUTPUT

NODE NUMBER	TEMPERATURE (R)	PROJECTED AREAS (IN2) AT EACH ASPECT ANGLE 0.	30.0
1	2008.0	0.	96.0
2	1388.0	0.	33.1
3	2008.0	0.	0.
4	2008.0	0.	0.
5	2008.0	705.7	446.9
6	2108.0	0.	0.

NODE	AREA (SQ.INCHES),	DIRECT EMISSIONS	REFLECTED EMISSIONS (WATTS/STERADIAN)	RADIOSITY	CUMULATIVE EMISSIONS

ASP = 0. DEGREES, WAVELENGTH BAND 1.8 - 2.7 TOTAL EMISSIONS = 1851.30

1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.41035E 02
3	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.
5	0.70568E 03	0.17249E 04	0.12661E 03	0.18513E 04	0.18103E 04
6	0.	0.	0.	0.	0.

ASP = 0. DEGREES, WAVELENGTH BAND 3.9 - 4.8 TOTAL EMISSIONS = 1253.16

1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.84010E 02
3	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.
5	0.70568E 03	0.11140E 04	0.13915E 03	0.12532E 04	0.11691E 04
6	0.	0.	0.	0.	0.

ASP = 30.00DEGREES, WAVELENGTH BAND 1.8 - 2.7 TOTAL EMISSIONS = 1574.23

1	0.96361E 02	0.23553E 03	0.14234E 03	0.37787E 03	0.29790E 03
2	0.33107E 02	0.64742E 01	0.17424E 02	0.23899E 02	0.33746E 02
3	0.	0.	0.	0.	0.24749E 02
4	0.	0.	0.	0.	0.28782E 02
5	0.44692E 03	0.10924E 04	0.80058E 02	0.11725E 04	0.11626E 04
6	0.	0.	0.	0.	0.26440E 02

ASP = 30.00DEGREES, WAVELENGTH BAND 3.9 - 4.8 TOTAL EMISSIONS = 1062.01

1	0.96361E 02	0.15212E 03	0.89940E 02	0.24206E 03	0.10240E 03
2	0.33107E 02	0.13255E 02	0.13052E 02	0.26307E 02	0.69087E 02
3	0.	0.	0.	0.	0.15984E 02
4	0.	0.	0.	0.	0.18586E 02
5	0.44692E 03	0.70552E 03	0.88125E 02	0.79365E 03	0.75086E 03
6	0.	0.	0.	0.	0.15086E 02

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1.4491 WT/ST
FROM 3.90 TO 4.80 MICRONS = 30.4410 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1851.3023 WT/ST
FROM 3.90 TO 4.80 MICRONS = 1253.1561 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 18

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0031 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.1129 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 560.0208 WT/ST
FROM 3.90 TO 4.80 MICRONS = 560.4628 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 19

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 8.3132 WT/ST
FROM 3.90 TO 4.80 MICRONS = 174.6405 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 2016.0279 WT/ST
FROM 3.90 TO 4.80 MICRONS = 1313.7351 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 20

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0176 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.6479 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 425.4550 WT/ST
FROM 3.90 TO 4.80 MICRONS = 429.6464 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 21

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET

EXTENDED HOT PARTS GEOMETRY

EXHAUST SURFACE COORDINATES, IN.

0.	50.00	70.00
20.00	23.80	14.60

CENTERBODY COORDINATES,IN./

0.	30.00	50.00	70.00
10.00	10.00	20.00	0.

```
                    SYSTEM INTERNAL VIEW FACTORS
        F( 1, 1)= 0.44018              F( 1, 1)= 0.44018
        F( 1, 2)= 0.03966              F( 2, 1)= 0.10526
        F( 1, 3)= 0.22935              F( 3, 1)= 0.85758
        F( 1, 4)= 0.26879              F( 4, 1)= 0.69895
        F( 1, 5)= 0.                   F( 5, 1)= 0.
        F( 1, 6)= 0.12645              F( 6, 1)= 0.83195
        F( 1, 7)= 0.00473              F( 7, 1)= 0.04978
                 AREA( 1)= 7048.19 SQ. IN.

        F( 2, 1)= 0.10526              F( 1, 2)= 0.03966
        F( 2, 2)= 0.21116              F( 2, 3)= 0.21116
        F( 2, 3)= 0.00856              F( 3, 2)= 0.01206
        F( 2, 4)= 0.02969              F( 4, 2)= 0.03742
        F( 2, 5)= 0.47502              F( 5, 2)= 0.70986
        F( 2, 6)= 0.01492              F( 6, 2)= 0.03699
        F( 2, 7)= 0.11490              F( 7, 2)= 0.45568
                 AREA( 2)= 2655.77 SQ. IN.

        F( 3, 1)= 0.85758              F( 1, 3)= 0.22935
        F( 3, 2)= 0.01206              F( 2, 3)= 0.0[illegible]
        F( 3, 3)= 0.                   F( 3, 3)= 0.
        F( 3, 4)= 0.00981              F( 4, 3)= 0.00878
        F( 3, 5)= 0.                   F( 5, 3)= 0.
        F( 3, 6)= 0.12331              F( 6, 3)= 0.21697
        F( 3, 7)= 0.                   F( 7, 3)= 0.
                 AREA( 3)= 1884.96 SQ. IN.

        F( 4, 1)= 0.69895              F( 1, 4)= 0.26879
        F( 4, 2)= 0.03742              F( 2, 4)= 0.02969
        F( 4, 3)= 0.00878              F( 3, 4)= 0.00981
        F( 4, 4)= 0.                   F( 4, 4)= 0.
        F( 4, 5)= 0.                   F( 5, 4)= 0.
        F( 4, 6)= 0.0325               F( 6, 4)= 0.06410
        F( 4, 7)= 0.                   F( 7, 4)= 0.
                 AREA( 4)= 2107.44 SQ. IN.

        F( 5, 1)= 0.                   F( 1, 5)= 0.
        F( 5, 2)= 0.70986              F( 2, 5)= 0.47502
        F( 5, 3)= 0.                   F( 3, 5)= 0.
        F( 5, 4)= 0.                   F( 4, 5)= 0.
        F( 5, 5)  0.                   F( 5, 5)= 0.
        F( 5, 6)  0.                   F( 6, 5)= 0.
        F( 5, 7)= 0.166[illegible]     F( 7, 5)= 0.44128
                 AREA(     1777.15 SQ. IN.

        F( 6, 1)= 0.83195              F( 1, 6)= 0.12645
        F( 6, 2)= 0.03699              F( 2, 6)= 0.01492
        F( 6, 3)= 0.21697              F( 3, 6)= 0.12331
        F( 6, 4)= 0.06410              F( 4, 6)= 0.03259
        F( 6, 5)= 0.                   F( 5, 6)= 0.
        F( 6, 6)= 0.                   F( 6, 6)= 0.
        F( 6, 7)= 0.                   F( 7, 6)= 0.
                 AREA( 6)= 1071.28 SQ. IN.

        F( 7, 1)= 0.04978              F( 1, 7)= 0.00473
        F( 7, 2)= 0.45568              F( 2, 7)= 0.11490
        F( 7, 3)= 0.                   F( 3, 7)= 0.
        F( 7, 4)= 0.                   F( 4, 7)= 0.
        F( 7, 5)= 0.44128              F( 5, 7)= 0.16628
        F( 7, 6)= 0.                   F( 6, 7)= 0.
        F( 7, 7)= 0.                   F( 7, 7)= 0.
                 AREA( 7)=  669.[illegible]6 SQ. IN.
```

EXHAUST HOT PARTS INPUT/OUTPUT

NODE NUMBER	TEMPERATURE (F)	PROJECTED AREAS (IN2) AT EACH ASPECT ANGLE 0.	30.0
1	2000.0	0.	93.0
2	1300.0	0.	33.3
3	2000.0	0.	0.
4	2000.0	0.	0.
5	1200.0	705.7	446.9
6	2100.0	0.	0.

NODE	AREA (SQ.INCHES),	DIRECT EMISSIONS (WATTS/STERADIAN)	REFLECTED EMISSIONS	RADIOSITY	CUMULATIVE EMISSIONS
ASP = 0. DEGREES,		WAVELENGTH BAND 1.8 - 2.7			TOTAL EMISSIONS = 100.60
1	0.	0.	0.	0.	0.25111E 02
2	0.	0.	0.	0.	0.38745E 02
3	0.	0.	0.	0.	0.34917E 01
4	0.	0.	0.	0.	0.74090E 01
5	0.70568E 03	0.1[illegible]4E 02	0.83407E 02	0.10060E 03	0.17997E 02
6	0.	0.	0.	0.	0.78465E 01
ASP = 0. DEGREES,		WAVELENGTH BAND 3.9 - 4.8			TOTAL EMISSIONS = 201.88
1	0.	0.	0.	0.	0.16218E 02
2	0.	0.	0.	0.	0.79323E 02
3	0.	0.	0.	0.	0.22551E 01
4	0.	0.	0.	0.	0.47850E 01
5	0.70568E 03	0.90590E 02	0.11129E 03	0.20188E 03	0.94823E 02
6	0.	0.	0.	0.	0.44776E 01
ASP = 30.00DEGREES,		WAVELENGTH BAND 1.8 - 2.7			TOTAL EMISSIONS = 499.17
1	0.93822E 02	0.22933E 03	0.14029E 03	0.36962E 03	0.31046E 03
2	0.33299E 02	0.65039E 01	0.93370E 01	0.15841E 02	0.32301E 02
3	0.	0.	0.	0.	0.26236E 02
4	0.	0.	0.	0.	0.33486E 02
5	0.44692E 03	0.10889E 02	0.52823E 02	0.63712E 02	0.11559E 02
6	0.	0.	0.	0.	0.35132E 02
ASP = 30.00DEGREES,		WAVELENGTH BAND 3.9 - 4.8			TOTAL EMISSIONS = 386.10
1	0.93822E 02	0.14811E 03	0.89056E 02	0.23717E 03	0.20051E 03
2	0.33299E 02	0.13315E 02	0.78215E 01	0.21137E 02	0.66130E 02
3	0.	0.	0.	0.	0.16947E 02
4	0.	0.	0.	0.	0.21627E 02
5	0.44692E 03	0.57372E 02	0.70483E 02	0.12796E 03	0.60962E 02
6	0.	0.	0.	0.	0.20040E 02

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1.0891 WT/ST
FROM 3.90 TO 4.80 MICRONS = 30.0418 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 100.6004 WT/ST
FROM 3.90 TO 4.80 MICRONS = 201.8816 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 22

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0031 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.1129 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 20.5016 WT/ST
FROM 3.90 TO 4.80 MICRONS = 66.0237 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 23

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 8.3132 WT/ST
FROM 3.90 TO 4.80 MICRONS = 174.6405 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 449.1727 WT/ST
FROM 3.90 TO 4.80 MICRONS = 386.1573 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 24

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0176 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.6479 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 94.4395 WT/ST
FROM 3.90 TO 4.80 MICRONS = 126.2896 WT/ST

CASE 25

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET

EXTENDED HOT PARTS GEOMETRY

EXHAUST SURFACE COORDINATES, IN.

0.	50.00	70.00
20.00	23.80	14.60

CENTERBODY COORDINATES, IN./

0.	30.00	50.00	70.00
10.00	10.00	20.00	0.

SYSTEM INTERNAL VIEW FACTORS

```
F( 1, 1)= 0.48018          F( 1, 1)= 0.48018
F( 1, 2)= 0.03966          F( 2, 1)= 0.10526
F( 1, 3)= 0.22935          F( 3, 1)= 0.05758
F( 1, 4)= 0.26879          F( 4, 1)= 0.09845
F( 1, 5)= 0.               F( 5, 1)= 0.
F( 1, 6)= 0.12645          F( 6, 1)= 0.03195
F( 1, 7)= 0.00473          F( 7, 1)= 0.04978
        AREA( 1)= 7048.19 SQ. IN.

F( 2, 1)= 0.10526          F( 1, 2)= 0.03966
F( 2, 2)= 0.21116          F( 2, 2)= 0.21116
F( 2, 3)= 0.00856          F( 3, 2)= 0.01206
F( 2, 4)= 0.02969          F( 4, 2)= 0.03742
F( 2, 5)= 0.47502          F( 5, 2)= 0.70986
F( 2, 6)= 0.01492          F( 6, 2)= 0.03699
F( 2, 7)= 0.11498          F( 7, 2)= 0.45568
        AREA( 2)= 2655.77 SQ. IN.

F( 3, 1)= 0.05758          F( 1, 3)= 0.22935
F( 3, 2)= 0.01206          F( 2, 3)= 0.00856
F( 3, 3)= 0.               F( 3, 3)= 0.
F( 3, 4)= 0.00981          F( 4, 3)= 0.00878
F( 3, 5)= 0.               F( 5, 3)= 0.
F( 3, 6)= 0.12331          F( 6, 3)= 0.21697
F( 3, 7)= 0.               F( 7, 3)= 0.
        AREA( 3)= 1884.96 SQ. IN.

F( 4, 1)= 0.09845          F( 1, 4)= 0.26879
F( 4, 2)= 0.03742          F( 2, 4)= 0.02969
F( 4, 3)= 0.00878          F( 3, 4)= 0.00981
F( 4, 4)= 0.               F( 4, 4)= 0.
F( 4, 5)= 0.               F( 5, 4)= 0.
F( 4, 6)= 0.03259          F( 6, 4)= 0.06410
F( 4, 7)= 0.               F( 7, 4)= 0.
        AREA( 4)= 2107.44 SQ. IN.

F( 5, 1)= 0.               F( 1, 5)= 0.
F( 5, 2)= 0.70986          F( 2, 5)= 0.47502
F( 5, 3)= 0.               F( 3, 5)= 0.
F( 5, 4)= 0.               F( 4, 5)= 0.
F( 5, 5)= 0.               F( 5, 5)= 0.
F( 5, 6)= 0.               F( 6, 5)= 0.
F( 5, 7)= 0.16628          F( 7, 5)= 0.44128
        AREA( 5)= 1777.15 SQ. IN.

F( 6, 1)= 0.03195          F( 1, 6)= 0.12645
F( 6, 2)= 0.03699          F( 2, 6)= 0.01492
F( 6, 3)= 0.21697          F( 3, 6)= 0.12331
F( 6, 4)= 0.06410          F( 4, 6)= 0.03259
F( 6, 5)= 0.               F( 5, 6)= 0.
F( 6, 6)= 0.               F( 6, 6)= 0.
F( 6, 7)= 0.               F( 7, 6)= 0.
        AREA( 6)= 1071.28 SQ. IN.

F( 7, 1)= 0.04978          F( 1, 7)= 0.00473
F( 7, 2)= 0.45568          F( 2, 7)= 0.11498
F( 7, 3)= 0.               F( 3, 7)= 0.
F( 7, 4)= 0.               F( 4, 7)= 0.
F( 7, 5)= 0.44128          F( 5, 7)= 0.16628
F( 7, 6)= 0.               F( 6, 7)= 0.
F( 7, 7)= 0.               F( 7, 7)= 0.
        AREA( 7)= 669.66 SQ. IN.
```

EXHAUST HOT PARTS INPUT/OUTPUT

NODE NUMBER	TEMPERATURE (R)	PROJECTED AREAS (IN2) AT EACH ASPECT ANGLE 0.	30.0
1	4008.0	0.	93.8
2	1100.0	0.	33.1
3	2008.0	0.	0.
4	2008.0	0.	0.
5	1100.0	705.7	446.9
6	2108.0	0.	0.

NODE	AREA (SQ.INCHES),	DIRECT EMISSIONS (WATTS/STERADIAN)	REFLECTED EMISSIONS	RADIOSITY	CUMULATIVE EMISSIONS
	ASP = 0. DEGREES,		WAVELENGTH BAND 1.8 - 2.7		TOTAL EMISSIONS = 66.69
1	0.	0.	0.	0.	0.25111E 02
2	0.	0.	0.	0.	0.40331E 01
3	0.	0.	0.	0.	0.34917E 01
4	0.	0.	0.	0.	0.74090E 01
5	0.70560E 03	0.17194E 02	0.49495E 02	0.66688E 02	0.17997E 02
6	0.	0.	0.	0.	0.78465E 01
	ASP = 0. DEGREES,		WAVELENGTH BAND 3.9 - 4.8		TOTAL EMISSIONS = 148.02
1	0.	0.	0.	0.	0.16218E 02
2	0.	0.	0.	0.	0.25465E 02
3	0.	0.	0.	0.	0.22551E 01
4	0.	0.	0.	0.	0.47850E 01
5	0.70560E 03	0.90590E 02	0.57434E 02	0.14802E 03	0.94823E 02
6	0.	0.	0.	0.	0.44776E 01
	ASP = 30.00DEGREES,		WAVELENGTH BAND 1.8 - 2.7		TOTAL EMISSIONS = 420.90
1	0.93822E 02	0.22933E 03	0.13994E 03	0.36927E 03	0.31046E 03
2	0.33299E 02	0.11130E 00	0.85800E 01	0.98001E 01	0.40293E 01
3	0.	0.	0.	0.	0.26236E 02
4	0.	0.	0.	0.	0.33686E 02
5	0.44692E 03	0.10889E 02	0.31346E 02	0.42235E 02	0.11559E 02
6	0.	0.	0.	0.	0.35132E 02
	ASP = 30.30DEGREES,		WAVELENGTH BAND 3.9 - 4.8		TOTAL EMISSIONS = 341.26
1	0.93822E 02	0.14811E 03	0.88494E 02	0.23660E 03	0.24051E 03
2	0.33299E 02	0.42746E 01	0.66334E 01	0.10908E 02	0.2 230E 02
3	0.	0.	0.	0.	0.14444E 02
4	0.	0.	0.	0.	0.41627E 02
5	0.44692E 03	0.57372E 02	0.36374E 02	0.93746E 02	0.40902E 02
6	0.	0.	0.	0.	0.29048E 02

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1.4491 WT/ST
FROM 3.90 TO 4.80 MICRONS = 30.4410 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 36.6881 WT/ST
FROM 3.90 TO 4.80 MICRONS = [illegible].0237 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 26

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	0.0031	WT/ST
FROM 3.90 TO 4.80	MICRONS =	0.1129	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.80	MICRONS =	13.7402	WT/ST
FROM 3.90 TO 4.80	MICRONS =	48.4099	WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 27

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 0. FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	8.3132	WT/ST
FROM 3.90 TO 4.80	MICRONS =	174.6405	WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	620.9008	WT/ST
FROM 3.90 TO 4.80	MICRONS =	341.2573	WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 28

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0176 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.6479 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 80.6950 WT/ST
FROM 3.90 TO 4.80 MICRONS = 111.6054 WT/ST

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 29

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET

EXTENDED HOT PARTS GEOMETRY

EXHAUST SURFACE COORDINATES, IN.

0.	50.00	70.00
20.00	23.80	14.60

CENTERBODY COORDINATES, IN./

0.	30.00	50.00	70.00
10.00	10.00	20.00	0.

EXHAUST HOT PARTS INPUT/OUTPUT

* *

NODE NUMBER	TEMPERATURE (R)	PROJECTED AREAS (IN2) AT EACH ASPECT ANGLE 0.	30.0
1	2000.0	0.	93.0
2	1100.0	0.	33.3
3	2000.0	0.	0.
4	2000.0	0.	0.
5	1100.0	705.7	446.9
6	2100.0	0.	0.

* *

* *

NODE	AREA (SQ.INCHES),	DIRECT EMISSIONS (WATTS/STERADIAN)	REFLECTED EMISSIONS	RADIOSITY	CUMULATIVE EMISSIONS
	ASP = 0. DEGREES,		WAVELENGTH BAND	1.8 - 2.7	TOTAL EMISSIONS = 26.85
1	0.	0.	0.	0.	0.45796E 00
2	0.	0.	0.	0.	0.90231E 00
3	0.	0.	0.	0.	0.63696E-01
4	0.	0.	0.	0.	0.13525E 00
5	0.70560E 03	0.25129E 02	0.17230E 01	0.26853E 02	0.25150E 02
6	0.	0.	0.	0.	0.14312E 00
	ASP = 0. DEGREES,		WAVELENGTH BAND	3.9 - 4.8	TOTAL EMISSIONS = 137.77
1	0.	0.	0.	0.	0.29577E 00
2	0.	0.	0.	0.	0.47541E 01
3	0.	0.	0.	0.	0.41130E-01
4	0.	0.	0.	0.	0.87349E-01
5	0.70560E 03	0.13260E 03	0.53730E 01	0.13777E 03	0.13251E 03
6	0.	0.	0.	0.	0.91673E-01
	ASP = 30.00DEGREES,		WAVELENGTH BAND	1.8 - 2.7	TOTAL EMISSIONS = 388.00
1	0.93022E 02	0.22933E 03	0.13945E 03	0.36878E 03	0.29038E 03
2	0.33299E 02	0.11057E 01	0.11059E 01	0.22917E 01	0.18370E 01
3	0.	0.	0.	0.	0.23449E 02
4	0.	0.	0.	0.	0.27586E 02
5	0.44692E 03	0.15913E 02	0.10917E 01	0.17006E 02	0.15950E 02
6	0.	0.	0.	0.	0.28865E 02
	ASP = 30.00DEGREES,		WAVELENGTH BAND	3.9 - 4.8	TOTAL EMISSIONS = 330.73
1	0.93022E 02	0.14011E 03	0.88227E 02	0.23634E 03	0.18754E 03
2	0.33299E 02	0.62475E 01	0.89564E 00	0.71431E 01	0.96707E 01
3	0.	0.	0.	0.	0.15144E 02
4	0.	0.	0.	0.	0.17816E 02
5	0.44692E 03	0.83851E 02	0.34028E 01	0.87254E 02	0.84081E 02
6	0.	0.	0.	0.	0.16472E 02

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1.0001 WT/ST
FROM 3.90 TO 4.80 MICRONS = 39.4418 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 26.8527 WT/ST
FROM 3.90 TO 4.80 MICRONS = 137.7733 WT/ST

```
                    PIREP TEST PROBLEM  5
                    HOT PARTS SUPPRESSION II
                                                    CASE  30

           PIREP EXTENSION STUDY

      ELEVATION ANGLE=  0.   DEGREES
      ASPECT RATIO =    1.00
      ASPECT ANGLE =    0.   DEGREES
      RANGE =        50000.00 FEET

       PLUME IR TOTALS

                 FROM 1.80 TO 2.70  MICRONS =       0.0031  WT/ST
                 FROM 3.90 TO 4.80  MICRONS =       0.1129  WT/ST

       ATTENUATED HOT PARTS IR TOTALS

                 FROM 1.80 TO 2.70  MICRONS =       4.9254  WT/ST
                 FROM 3.90 TO 4.80  MICRONS =      45.0576  WT/ST


                    PIREP TEST PROBLEM  5
                    HOT PARTS SUPPRESSION II
                                                    CASE  31

           PIREP EXTENSION STUDY

      ELEVATION ANGLE=  0.   DEGREES
      ASPECT RATIO =    1.00
      ASPECT ANGLE =   30.00 DEGREES
      RANGE =           0.   FEET

       PLUME IR TOTALS

                 FROM 1.80 TO 2.70  MICRONS =       8.3132  WT/ST
                 FROM 3.90 TO 4.80  MICRONS =     174.6405  WT/ST

       ATTENUATED HOT PARTS IR TOTALS

                 FROM 1.80 TO 2.70  MICRONS =     388.0783  WT/ST
                 FROM 3.90 TO 4.80  MICRONS =     330.7339  WT/ST
```

PIREP TEST PROBLEM 5
HOT PARTS SUPPRESSION II

CASE 32

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0176 WT/ST
FROM 3.90 TO 4.80 MICRONS = 0.6479 WT/ST

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 81.7324 WT/ST
FROM 3.90 TO 4.80 MICRONS = 108.1638 WT/ST

PIREP TEST PROBLEM 6
SPECTRAL SIGNATURE AND LOCKON

CASE 1

** PIREP OUTPUT **

T7	1388.00	T5	2008.00
P8	56.82	A8	534.60
PAMB	14.70	XM	1.00
VC19	0.	ALT	0.
FAR	0.01		

IR INDICES

	1.8-2.7	3.9-4.8
PLUME	17.	349.
HOT PTS	2010.	1298.

* * * * * * * * * * * * * * * * * * * *

MISSILE PARAMETERS

* * * * * * * * * * * * * * * * * * * *

NO.	WAVELENGTH BAND (MICRONS)	SENSITIVITY	NEI (WATTS/CM**2)	S/N
1	1.80 -.700	1.0	0.2000E-09	3.0
2	3.90 -.800	1.0	0.4000E-10	0.7

PIREP TEST PROBLEM 6
SPECTRAL SIGNATURE AND LUCKON

CASE 1

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 5000.00 FEET
ATMS/

519.0000	1.0000	0.	0.
519.0000	1.0000	0.	00000.0000

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM 1.80 TO 2.70 MICRONS = 0.7257 WT/SR
FROM 3.90 TO 4.80 MICRONS = 0.5686 WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0237 WT/SR
FROM 3.90 TO 4.80 MICRONS = 1.2522 WT/SR

EXTENDED HOT PARTS GEOMETRY

EXHAUST SURFACE COORDINATES, IN.

0.	50.00	70.00
20.00	23.80	14.60

CENTERBODY COORDINATES,IN./

0.	30.00	50.00	70.00
10.00	10.00	20.00	0.

WAVELENGTH (MICRONS)	IRRADIANCE (WATTS/STER/MICRON)	TRANSMISSIVITY	WAVELENGTH (MICRONS)	IRRADIANCE (WATTS/STER/MICRON)	TRANSMISSIVITY
1.8000	0.0020	0.7520	2.6400	0.1126	0.4844
1.8200	0.0029	0.6634	2.6600	0.1265	0.5524
1.8400	0.0038	0.4549	2.6800	0.0066	0.0066
1.8600	0.0035	0.8968	2.7000	0.0107	0.0103
1.8800	0.0041	0.6756	3.9000	0.0001	0.9567
1.9000	0.0045	0.6745	4.0000	0.0000	0.9466
1.9200	0.0055	0.6652	4.1000	0.0000	0.6415
1.9400	0.0061	0.6918	4.1100	-0.0000	0.6151
1.9600	0.0061	0.6591	4.1200	-0.0000	0.7995
1.9800	0.0055	0.7883	4.1300	-0.0000	0.7715
2.0000	0.0065	0.5619	4.1400	0.0000	0.7678
2.0200	0.0055	0.7321	4.1500	-0.0000	0.7255
2.0400	0.0013	0.6770	4.1600	-0.0000	0.7653
2.0600	0.0023	0.8146	4.1700	1.5759	0.6556
2.0800	0.0012	0.8406	4.1800	9.9676	0.9518
2.1000	0.0001	0.8952	4.1900	0.0083	0.0001
2.1500	0.0000	0.6995	4.2000	0.0000	0.0000
2.2000	0.0000	0.9013	4.2250	0.0000	0.0000
2.2500	0.0000	0.9439	4.2500	0.0000	0.0000
2.3000	-0.0000	0.9064	4.2750	0.0000	0.0000
2.3200	0.0000	0.9069	4.3000	0.0000	0.0000
2.3400	0.0000	0.9076	4.3250	0.0000	0.0000
2.3600	0.0000	0.9185	4.3500	0.0068	0.0000
2.3800	0.0001	0.9097	4.3750	0.3425	0.0004
2.4000	0.0006	0.9096	4.4000	1.0014	0.0013
2.4200	0.0035	0.9037	4.4250	1.8484	0.0177
2.4400	0.0137	0.8409	4.4500	4.1518	0.0671
2.4600	0.0344	0.8292	4.4750	9.2592	0.2197
2.4800	0.0586	0.7530	4.5000	11.1985	0.4779
2.5000	0.0797	0.6641	4.5250	6.9065	0.6944
2.5200	0.0967	0.5741	4.5500	2.9577	0.6120
2.5400	0.1089	0.4939	4.5750	1.0776	0.8662
2.5600	0.1164	0.4326	4.6000	0.3746	0.8914
2.5800	0.1204	0.3955	4.7000	0.4203	0.9150
2.6000	0.1221	0.3967	4.8000	1.6956	0.8854
2.6200	0.1211	0.4122	4.8000	1.6956	0.8554

SYSTEM INTERNAL VIEW FACTORS

```
F( 1, 1)= 0.44016          F( 1, 1)= 0.44016
F( 1, 2)= 0.03966          F( 2, 1)= 0.10526
F( 1, 3)= 0.22935          F( 3, 1)= 0.05758
F( 1, 4)= 0.26879          F( 4, 1)= 0.09895
F( 1, 5)= 0.               F( 5, 1)= 0.
F( 1, 6)= 0.12645          F( 6, 1)= 0.03195
F( 1, 7)= 0.00473          F( 7, 1)= 0.04978
        AREA( 1)= 7060.19 SQ. IN.

F( 2, 1)= 0.10526          F( 1, 2)= 0.03966
F( 2, 2)= 0.21116          F( 2, 2)= 0.21116
F( 2, 3)= 0.00856          F( 3, 2)= 0.01206
F( 2, 4)= 0.02969          F( 4, 2)= 0.03742
F( 2, 5)= 0.47502          F( 5, 2)= 0.70986
F( 2, 6)= 0.01492          F( 6, 2)= 0.03699
F( 2, 7)= 0.11490          F( 7, 2)= 0.45566
        AREA( 2)= 2655.77 SQ. IN.

F( 3, 1)= 0.05758          F( 1, 3)= 0.22935
F( 3, 2)= 0.01206          F( 2, 3)= 0.00856
F( 3, 3)= 0.               F( 3, 3)= 0.
F( 3, 4)= 0.00981          F( 4, 3)= 0.00878
F( 3, 5)= 0.               F( 5, 3)= 0.
F( 3, 6)= 0.12331          F( 6, 3)= 0.21697
F( 3, 7)= 0.               F( 7, 3)= 0.
        AREA( 3)= 1084.96 SQ. IN.

F( 4, 1)= 0.09895          F( 1, 4)= 0.26879
F( 4, 2)= 0.03742          F( 2, 4)= 0.02969
F( 4, 3)= 0.00878          F( 3, 4)= 0.00981
F( 4, 4)= 0.               F( 4, 4)= 0.
F( 4, 5)= 0.               F( 5, 4)= 0.
F( 4, 6)= 0.03259          F( 6, 4)= 0.06410
F( 4, 7)= 0.               F( 7, 4)= 0.
        AREA( 4)= 2107.88 SQ. IN.

F( 5, 1)= 0.               F( 1, 5)= 0.
F( 5, 2)= 0.70986          F( 2, 5)= 0.47502
F( 5, 3)= 0.               F( 3, 5)= 0.
F( 5, 4)= 0.               F( 4, 5)= 0.
F( 5, 5)= 0.               F( 5, 5)= 0.
F( 5, 6)= 0.               F( 6, 5)= 0.
F( 5, 7)= 0.16626          F( 7, 5)= 0.44128
        AREA( 5)= 1777.15 SQ. IN.

F( 6, 1)= 0.03195          F( 1, 6)= 0.12645
F( 6, 2)= 0.03699          F( 2, 6)= 0.01492
F( 6, 3)= 0.21697          F( 3, 6)= 0.12331
F( 6, 4)= 0.06410          F( 4, 6)= 0.03259
F( 6, 5)= 0.               F( 5, 6)= 0.
F( 6, 6)= 0.               F( 6, 6)= 0.
F( 6, 7)= 0.               F( 7, 6)= 0.
        AREA( 6)= 1071.28 SQ. IN.

F( 7, 1)= 0.04978          F( 1, 7)= 0.00473
F( 7, 2)= 0.45566          F( 2, 7)= 0.11490
F( 7, 3)= 0.               F( 3, 7)= 0.
F( 7, 4)= 0.               F( 4, 7)= 0.
F( 7, 5)= 0.44128          F( 5, 7)= 0.16628
F( 7, 6)= 0.               F( 6, 7)= 0.
F( 7, 7)= 0.               F( 7, 7)= 0.
        AREA( 7)= 667.80 SQ. IN.
```

EXHAUST HOT PARTS INPUT/OUTPUT

NODE NUMBER	TEMPERATURE (R)	PROJECTED AREAS (IN2) AT EACH ASPECT ANGLE 0.	30.0	60.0
1	2400.0	0.	93.8	0.
2	1100.0	0.	33.3	266.1
3	2000.0	0.	0.	0.
4	2000.0	0.	0.	0.
5	1100.0	705.7	446.0	68.6
6	2100.0	0.	0.	0.

NODE	AREA (SQ.INCHES),	DIRECT EMISSIONS (WATTS/STERADIAN)	REFLECTED EMISSIONS	RADIOSITY	CUMULATIVE EMISSIONS

ASP = 0. DEGREES, WAVELENGTH BAND 1.8 - 2.7 TOTAL EMISSIONS = 66.69

1	0.	0.	0.	0.	0.25111E 02
2	0.	0.	0.	0.	0.49131E 01
3	0.	0.	0.	0.	0.34917E 01
4	0.	0.	0.	0.	0.74090E 01
5	0.70568E 03	0.17194E 02	0.49495E 02	0.66688E 02	0.17997E 02
6	0.	0.	0.	0.	0.78465E 01

ASP = 0. DEGREES, WAVELENGTH BAND 3.9 - 4.8 TOTAL EMISSIONS = 148.02

1	0.	0.	0.	0.	0.16218E 02
2	0.	0.	0.	0.	0.25465E 02
3	0.	0.	0.	0.	0.22551E 01
4	0.	0.	0.	0.	0.47850E 01
5	0.70568E 03	0.46590E 02	0.57434E 02	0.14802E 03	0.94823E 02
6	0.	0.	0.	0.	0.44776E 01

ASP = 30.00DEGREES, WAVELENGTH BAND 1.8 - 2.7 TOTAL EMISSIONS = 420.90

1	0.93822E 02	0.22933E 03	0.13994E 03	0.36927E 03	0.31006E 03
2	0.33299E 02	0.81130E 00	0.65880E 01	0.94001E 01	0.40293E 01
3	0.	0.	0.	0.	0.26236E 02
4	0.	0.	0.	0.	0.33486E 02
5	0.44692E 03	0.12089E 02	0.31346E 02	0.42235E 02	0.11559E 02
6	0.	0.	0.	0.	0.35132E 02

ASP = 30.00DEGREES, WAVELENGTH BAND 3.9 - 4.8 TOTAL EMISSIONS = 341.26

1	0.93822E 02	0.14811E 03	0.88494E 02	0.23660E 03	0.20051E 03
2	0.33299E 02	0.42746E 01	0.66334E 01	0.10908E 02	0.21230E 02
3	0.	0.	0.	0.	0.16944E 02
4	0.	0.	0.	0.	0.21627E 02
5	0.44692E 03	0.57372E 02	0.36374E 02	0.93746E 02	0.60902E 02
6	0.	0.	0.	0.	0.20048E 02

ASP = 60.00DEGREES, WAVELENGTH BAND 1.8 - 2.7 TOTAL EMISSIONS = 81.23

1	0.	0.	0.	0.	0.40413E 02
2	0.26613E 03	0.54641E 01	0.68644E 02	0.75128E 02	0.77785E 01
3	0.	0.	0.	0.	0.56176E 01
4	0.	0.	0.	0.	0.11724E 02
5	0.68561E 02	0.15730E 01	0.45281E 01	0.61011E 01	0.28662E 01
6	0.	0.	0.	0.	0.12628E 02

ASP = 60.00DEGREES, WAVELENGTH BAND 3.9 - 4.8 TOTAL EMISSIONS = 100.78

1	0.	0.	0.	0.	0.26101E 0[illegible]
2	0.26613E 03	0.34164E 02	0.53016E 02	0.87180E 02	0.40983E 02
3	0.	0.	0.	0.	0.36294E 01
4	0.	0.	0.	0.	0.77010E 01
5	0.68561E 02	0.[illegible]870E 01	0.32545E 01	0.13542E 02	0.15[illegible]E 02
6	0.	0.	0.	0.	0.720[illegible]E 01

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 85.7590 WT/ST
FROM 3.90 TO 4.80 MICRONS = [illegible] WT/ST

PIREP TEST PROBLEM 6
SPECTRAL SIGNATURE AND LOCKON

CASE 2

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 50000.00 FEET

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM 1.80 TO 2.70 MICRONS =	0.2740	WT/SR
FROM 3.90 TO 4.80 MICRONS =	0.2498	WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS =	0.0031	WT/SR
FROM 3.90 TO 4.80 MICRONS =	0.1129	WT/SR

WAVELENGTH (MICRONS)	IRRADIANCE (WATTS/STER/MICRON)	TRANSMISSIVITY	WAVELENGTH (MICRONS)	IRRADIANCE (WATTS/STER/MICRON)	TRANSMISSIVITY
1.8000	0.0002	0.2255	2.6400	0.0157	0.2322
1.8200	0.0003	0.2080	2.6600	0.0151	0.2311
1.8400	0.0003	0.2029	2.6800	0.0000	0.0000
1.8600	0.0003	0.2194	2.7000	0.0000	0.0000
1.8800	0.0004	0.2160	3.9000	0.0000	0.6032
1.9000	0.0004	0.2190	4.0000	0.0000	0.5783
1.9200	0.0005	0.2191	4.1000	0.0000	0.2169
1.9400	0.0006	0.2312	4.1100	-0.0000	0.2016
1.9600	0.0003	0.1219	4.1200	0.0000	0.1711
1.9800	0.0005	0.2628	4.1300	-0.0000	0.1455
2.0000	0.0001	0.0537	4.1400	0.0000	0.1245
2.0200	0.0002	0.1392	4.1500	0.0000	0.1077
2.0400	0.0001	0.3113	4.1600	0.0000	0.0946
2.0600	0.0001	0.1981	4.1700	0.1583	0.0808
2.0800	0.0001	0.3129	4.1800	0.0603	0.0012
2.1000	0.0000	0.3320	4.1900	0.0000	0.0000
2.1500	0.0000	0.3431	4.2000	0.0000	0.0000
2.2000	-0.0000	0.3537	4.2250	0.	0.
2.2500	-0.0000	0.3641	4.2500	0.	0.
2.3000	-0.0000	0.3742	4.2750	0.	0.
2.3200	0.0000	0.3764	4.3000	0.0000	0.
2.3400	0.0000	0.3794	4.3250	0.0000	0.0000
2.3600	0.0000	0.3831	4.3500	0.0000	0.0000
2.3800	0.0000	0.3887	4.3750	0.0060	0.0000
2.4000	0.0001	0.3933	4.4000	0.0002	0.0000
2.4200	0.0004	0.3945	4.4250	0.0003	0.0000
2.4400	0.0018	0.3876	4.4500	0.0045	0.0003
2.4600	0.0045	0.3679	4.4750	0.0811	0.0063
2.4800	0.0077	0.3369	4.5000	0.5610	0.0524
2.5000	0.0105	0.2995	4.5250	1.1537	0.1481
2.5200	0.0129	0.2610	4.5500	0.4208	0.2823
2.5400	0.0146	0.2263	4.5750	0.3531	0.3536
2.5600	0.0158	0.1997	4.6000	0.1227	0.3988
2.5800	0.0164	0.1840	4.7000	0.0956	0.4758
2.6000	0.0168	0.1812	4.8000	0.3828	0.4090
2.6200	0.0168	0.1946	4.8000	0.3828	0.4090

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 17.2764 WT/ST
FROM 3.90 TO 4.80 MICRONS = 36.9781 WT/ST

PIREP TEST PROBLEM 6
SPECTRAL SIGNATURE AND LOCKON

CASE 3

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 5000.00 FEET

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM 1.80 TO 2.70 MICRONS = 0.8055 WT/SR
FROM 3.90 TO 4.80 MICRONS = 0.5669 WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.1361 WT/SR
FROM 3.90 TO 4.80 MICRONS = 7.1634 WT/SR

WAVELENGTH (MICRONS)	IRRADIANCE (WATTS/STER/MICRON)	TRANSMISSIVITY	WAVELENGTH (MICRONS)	IRRADIANCE (WATTS/STER/MICRON)	TRANSMISSIVITY
1.8000	0.0073	0.8394	2.6400	0.6987	0.7179
1.8200	0.0135	0.8092	2.6600	0.0280	0.7637
1.8400	0.0169	0.7955	2.6800	0.0415	0.0136
1.8600	0.0148	0.8174	2.7000	0.0054	0.0257
1.8800	0.0194	0.8077	3.9000	0.0002	0.9507
1.9000	0.0216	0.8079	4.0000	0.0000	0.9466
1.9200	0.0268	0.8039	4.1000	0.0000	0.8415
1.9400	0.0277	0.8182	4.1100	-0.0000	0.8191
1.9600	0.0279	0.7633	4.1200	-0.0000	0.7955
1.9800	0.0167	0.8593	4.1300	-0.0000	0.7715
2.0000	0.0150	0.6439	4.1400	0.0000	0.7478
2.0200	0.0113	0.7919	4.1500	-0.0000	0.7255
2.0400	0.0026	0.8887	4.1600	-0.0000	0.7053
2.0600	0.0047	0.8372	4.1700	6.3287	0.6826
2.0800	0.0072	0.8894	4.1800	108.2596	0.2045
2.1000	0.0001	0.8956	4.1900	0.9287	0.0009
2.1500	0.0000	0.8985	4.2000	0.0006	0.0000
2.2000	0.0000	0.9013	4.2250	0.0000	0.0000
2.2500	0.0000	0.9039	4.2500	0.0000	0.0000
2.3000	-0.0000	0.9064	4.2750	0.0000	0.0000
2.3200	0.0000	0.9069	4.3000	0.0000	0.0000
2.3400	0.0000	0.9074	4.3250	0.0001	0.0000
2.3600	0.0000	0.9085	4.3500	0.1602	0.0001
2.3800	0.0001	0.9098	4.3750	6.7498	0.0053
2.4000	0.0012	0.9108	4.4000	16.5865	0.0259
2.4200	0.0068	0.9105	4.4250	13.1 98	0.0432
2.4400	0.0300	0.9064	4.4500	26.0876	0.1257
2.4600	0.0980	0.8927	4.4750	52.6164	0.3466
2.4800	0.2303	0.8632	4.5000	55.3235	0.6257
2.5000	0.3969	0.8193	4.5250	29.9855	0.7816
2.5200	0.5485	0.7688	4.5500	12.0355	0.8477
2.5400	0.6681	0.7200	4.5750	4.2810	0.8787
2.5600	0.7562	0.6808	4.6000	1.4767	0.8956
2.5800	0.8122	0.6545	4.7000	1.6541	0.9199
2.6000	0.8372	0.6488	4.8000	6.9392	0.9055
2.6200	0.8053	0.6668	4.8000	6.9392	0.9055

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 327.8493 WT/ST
FROM 3.90 TO 4.80 MICRONS = 200.3010 WT/ST

PIREP TEST PROBLEM 6
SPECTRAL SIGNATURE AND LOCKON

CASE 4

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

AVERAGE PLUME/ATMOSPHERE RANSMISSIVITY

FROM 1.80 TO 2.70 MICRONS = 0.3052 WT/SR
FROM 3.90 TO 4.80 MICRONS = 0.2517 WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0176 WT/SR
FROM 3.90 TO 4.80 MICRONS = 0.6479 WT/SR

WAVE ENGTH (MICRONS)	IRRADIANCE (WATTS/STER/MICRON)	TRANSMISSIVITY	WAVELENGTH (MICRONS)	IRRADIANCE (WATTS/STER/MICRON)	TRANSMISSIVITY
1.8000	0.0006	0.2517	2.6400	0.0960	0.3414
1.8200	0.0012	0.2467	2.6600	0.0786	0.3178
1.8400	0.0015	0.2465	2.6800	0.0000	0.0000
1.8600	0.0013	0.2574	2.7000	0.0000	0.0000
1.8800	0.0018	0.2583	3.9000	0.0002	0.6032
1.9000	0.0020	0.2625	4.0000	0.0000	0.5783
1.9200	0.0026	0.2649	4.1000	0.0000	0.2349
1.9400	0.0027	0.2734	4.1100	-0.0000	0.2016
1.9600	0.0012	0.1404	4.1200	0.0000	0.1711
1.98[illegible]	0.0016	0.2879	4.1300	-0.0000	0.[illegible]5
2.0000	0.0003	0.0585	4.1400	0.0000	0.1245
2.0200	0.0004	0.1472	4.1500	0.0000	0.1077
2.0400	0.0003	0.3154	4.1600	0.0000	0.0946
2.0600	0.0002	0.1980	4.1700	0.8874	0.0837
2.0800	0.0002	0.3169	4.1800	0.5083	0.0023
2.1000	0.0000	0.3322	4.1900	0.0000	0.0000
2.1500	0.0000	0.3431	4.2000	0.0000	0.0000
2.2000	-0.0000	0.3537	4.2250	0.	0.
2.2500	-0.0000	0.3641	4.2500	0.	0.
2.3000	-0.0000	0.3742	4.2750	0.	0.
2.3200	0.0000	0.3764	4.3000	0.0000	0.0000
3400	0.0000	0.3794	4.3250	0.0000	0.0000
3600	0.0000	0.3831	4.3500	0.0000	0.0000
2.3800	0.0000	0.3888	4.3750	0.0000	0.0000
2.4000	0.0001	0.3938	4.4000	0.0012	0.0000
2.4200	0.0009	0.3972	4.4250	0.0017	0.0000
2.4400	0.0038	0.3988	4.4500	0.0282	0.0004
2.4600	0.0176	0.3961	4.4750	0.5041	0.0077
2.4800	0.0298	0.3862	4.5000	3.4457	0.0613
2.5000	0.0517	0.3695	4.5250	6.8267	0.1857
2.5200	0.0720	0.3495	4.5500	4.6318	0.2943
2.5400	0.0885	0.3279	4.5750	1.9473	0.3506
2.5600	0.1009	0.3140	4.6000	0.6714	0.4005
2.5800	0.1092	0.3045	4.7000	0.5152	0.4772
2.6000	0.1127	0.3039	4.8000	2.1148	0.4146
2.6200	0.1099	0.3148	4.8000	2.1148	0.4146

ATTENUATED HOT PARTS TO TOTALS

FROM 1.80 TO 2.70 MICRONS = 124.2083 WT/ST
FROM 3.90 TO 4.80 MICRONS = 85.8866 WT/ST

PIREP TEST PROBLEM 6
SPECTRAL SIGNATURE AND LOCKON

CASE 5

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 60.00 DEGREES
RANGE = 5000.00 FEET

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM 1.80 TO 2.70 MICRONS = 0.8213 WT/SR
FROM 3.90 TO 4.80 MICRONS = 0.5893 WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.2358 WT/SR
FROM 3.90 TO 4.80 MICRONS 12.4421 WT/SR

WAVELENGTH (MICRONS)	IRRADIANCE (WATTS/STER/MICRON)	TRANSMISSIVITY	WAVELENGTH (MICRONS)	IRRADIANCE (WATTS/STER/MICRON)	TRANSMISSIVITY
1.8000	0.0103	0.8527	2.6400	1.2400	0.7691
1.8200	0.0205	0.8321	2.6600	1.0391	0.8053
1.8400	0.0267	0.8223	2.6800	0.0709	0.0136
1.8600	0.0274	0.8382	2.7000	0.1124	0.0292
1.8800	0.0300	0.8322	3.9000	0.0004	0.9507
1.9000	0.0336	0.8328	4.0000	0.0000	0.9466
1.9200	0.0420	0.8302	4.1000	0.0000	0.8415
1.9400	0.0471	0.8411	4.1100	-0.0000	0.8191
1.9600	0.0328	0.7797	4.1200	-0.0000	0.7955
1.9800	0.0228	0.8695	4.1300	0.0000	0.7715
2.0000	0.0196	0.6527	4.1400	0.0000	0.7478
2.0200	0.0146	0.7978	4.1500	-0.0000	0.7255
2.0400	0.0033	0.8898	4.1600	-0.0000	0.7053
2.0600	0.0060	0.8392	4.1700	10.4468	0.6847
2.0800	0.0028	0.8902	4.1800	202.2225	0.2403
2.1000	0.0002	0.8956	4.1900	1.8402	0.0012
2.1500	0.0000	0.8985	4.2000	0.0014	0.0000
2.2000	0.0000	0.9013	4.2250	0.0000	0.0000
2.2500	0.0000	0.9039	4.2500	0.0000	0.0000
2.3000	-0.0000	0.9064	4.2750	0.0000	0.0000
2.3200	0.0000	0.9069	4.3000	0.0000	0.0000
2.3400	0.0000	0.9076	4.3250	0.0002	0.0000
2.3600	0.0000	0.9085	4.3500	0.3305	0.0001
2.3800	0.0002	0.9098	4.3750	13.3642	0.0072
2.4000	0.0015	0.9109	4.4000	30.4932	0.0306
2.4200	0.0087	0.9111	4.4250	22.9591	0.0471
2.4400	0.0389	0.9091	4.4500	45.0001	0.1337
2.4600	0.1310	0.9039	4.4750	89.9080	0.3626
2.4800	0.3334	0.8817	4.5000	93.1346	0.6421
2.5000	0.6282	0.8497	4.5250	49.8314	0.7902
2.5200	0.9306	0.8100	4.5500	19.8801	0.8510
2.5400	1.1787	0.7702	4.5750	7.0558	0.8790
2.5600	1.3604	0.7369	4.6000	2.4321	0.8960
2.5800	1.4748	0.7155	4.7000	2.7255	0.9203
2.6000	1.5146	0.7106	4.8000	11.4698	0.9073
2.6200	1.4574	0.7262	4.8000	11.4698	0.9073

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 64.1709 WT/ST
FROM 3.90 TO 4.80 MICRONS = 59.3588 WT/ST

PIREP TEST PROBLEM 6
SPECTRAL SIGNATURE AND LOCKON

CASE 6

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 60.00 DEGREES
RANGE = 50000.00 FEET

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM 1.80 TO 2.70 MICRONS = 0.3115 WT/SR
FROM 3.90 TO 4.80 MICRONS = 0.2519 WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 0.0305 WT/SR
FROM 3.90 TO 4.80 MICRONS = 1.1221 WT/SR

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 24.3427 WT/ST
FROM 3.90 TO 4.80 MICRONS = 25.3670 WT/ST

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LOCKON RANGE, FEET

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ASPECT ANGLE (DEG)	MISSILE NUMBER 1	2
0.	8226.	39481.
30.00	18504.	56403.
60.00	9469.	34642.

WAVELENGTH (MICRONS)	IRRADIANCE (WATTS/STER/MICRON)	TRANSMISSIVITY	WAVELENGTH (MICRONS)	IRRADIANCE (WATTS/STER/MICRON)	TRANSMISSIVITY
1.8000	0.0009	0.2517	2.6400	0.1697	0.3657
1.8200	0.0018	0.2537	2.6600	0.1233	0.3350
1.8400	0.0024	0.2548	2.6800	0.0000	0.0000
1.8600	0.0020	0.2641	2.7000	0.0000	0.0000
1.8800	0.0028	0.2661	3.9000	0.0003	0.0032
1.9000	0.0031	0.2703	4.0000	0.0000	0.5783
1.9200	0.0040	0.2735	4.1000	0.0000	0.2369
1.9400	0.0041	0.2811	4.1100	-0.0000	0.2016
1.9600	0.0017	0.1433	4.1200	0.0009	0.1711
1.9800	0.0022	0.2913	4.1300	-0.0000	0.1455
2.0000	0.0003	0.0590	4.1400	0.0000	0.1245
2.0200	0.0006	0.1480	4.1500	0.0000	0.1077
2.0400	0.0003	0.3158	4.1600	0.0000	0.0936
2.0600	0.0003	0.1904	4.1700	1.5432	0.0439
2.0800	0.0003	0.3163	4.1800	0.9162	0.0025
2.1000	0.0000	0.3527	4.1900	0.0000	0.0000
2.1500	0.0000	0.3631	4.2000	0.0000	0.0000
2.2000	-0.0000	0.3537	4.2250	0.	0.
2.2500	-0.0000	0.3691	4.2500	0.	0.
2.3000	-0.0000	0.3742	4.2750	0.	0.
2.3200	-0.0000	0.3764	4.3000	0.0000	0.0000
2.3400	0.0000	0.3794	4.3250	0.0000	0.0000
2.3600	0.0000	0.3831	4.3500	0.0000	0.0000
2.3800	0.0000	0.3888	4.3750	0.0003	0.0000
2.4000	0.0002	0.3939	4.4000	0.0021	0.0000
2.4200	0.0011	0.3975	4.4250	0.0031	0.0000
2.4400	0.0049	0.4000	4.4500	0.0493	0.0004
2.4600	0.0148	0.3998	4.4750	0.8792	0.0078
2.4800	0.0429	0.3945	4.5000	4.0033	0.0621
2.5000	0.0816	0.3832	4.5250	11.8521	0.1874
2.5200	0.1218	0.3683	4.5500	8.0059	0.2954
2.5400	0.1554	0.3529	4.5750	3.3585	0.3590
2.5600	0.1808	0.3403	4.6000	1.1572	0.4006
2.5800	0.1975	0.3329	4.7000	0.8888	0.4773
2.6000	0.2043	0.3330	4.8000	3.6497	0.4151
2.6200	0.1988	0.3428	4.9000	3.6497	0.4151

PIREP TEST PROBLEM 7
SPECTRAL SIGNATURE AND SPECIFIC MISSILES
CASE 1

** PIREP OUTPUT **

T7	1388.00	T5	2008.00
P8	56.82	A8	534.60
PAMB	14.70	XM	1.00
VC19	0.	ALT	0.
FAR	0.01		

IR INDICES

	1.8-2.7	3.9-4.8
PLUME	17.	349.
HOT PTS	2010.	1298.

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MISSILE PARAMETERS

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NO.	WAVELENGTH BAND (MICRONS)	SENSITIVITY	NEI (WATTS/CM**2)	S/N
1	4.17 -.250	1.0	0.4000E-10	0.7
2	4.40 -.600	1.0	0.4000E-10	0.7
3	1.80 -.700	1.0	0.2000E-09	3.0
4	3.90 -.800	1.0	0.4000E-10	0.7

PIREP TEST PROBLEM 7
SPECTRAL SIGNATURE AND SPECIFIC MISSILES
CASE 1

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 0. FEET
ATMS/

519.0000	1.0000	0.	0.
519.0000	1.0000	0.	00000.0000

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM 1.80 TO 2.70 MICRONS = 0.8168 WT/SR
FROM 3.90 TO 4.80 MICRONS = 0.6581 WT/SR
FROM 4.17 TO 4.25 MICRONS = 0.0722 WT/SR
FROM 4.40 TO 4.60 MICRONS = 0.5941 WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS = 1.4491 WT/SR
FROM 3.90 TO 4.80 MICRONS = 30.4418 WT/SR
FROM 4.17 TO 4.25 MICRONS = 4.1843 WT/SR
FROM 4.40 TO 4.60 MICRONS = 16.7383 WT/SR

7

BEST A[illegible] COPY

EXHAUST UNIT PARTS [illegible] OUTPUT

NODE NUMBER	TEMPERATURE (R)	PROJECTED AREAS (IN2) AT EACH ASPECT ANGLE 0.	30.0	170.0
1	2000.0	530.0	463.0	0.
2	1900.0	450.0	390.0	210.0

NODE	AREA (SQ.INCHES),	DIRECT EMISSIONS (WATTS/STERADIAN)	REFLECTED EMISSIONS	RADIOSITY	CUMULATIVE EMISSIONS
ASP = 0. DEGREES,		WAVELENGTH BAND 1.8 - 2.7		TOTAL EMISSIONS =	3230.95
1	0.53000E 03	0.20101E 04	0.20102E 00	0.20101E 04	0.20103E 04
2	0.45000E 03	0.12205E 04	0.12207E 00	0.12200E 04	0.12200E 04
ASP = 0. DEGREES,		WAVELENGTH BAND 3.9 - 4.8		TOTAL EMISSIONS =	2217.67
1	0.53000E 03	0.12992E 04	0.12990E 00	0.12990E 04	0.12990E 04
2	0.45000E 03	0.91422E 03	0.91031E-01	0.91031E 03	0.91031E 03
ASP = 0. DEGREES,		WAVELENGTH BAND 4.2 - 4.3		TOTAL EMISSIONS =	207.53
1	0.53000E 03	0.12194E 03	0.12190E-01	0.12195E 03	0.12195E 03
2	0.45000E 03	0.85573E 02	0.85503E-02	0.85502E 02	0.85582E 02
ASP = 0. DEGREES,		WAVELENGTH BAND 4.4 - 4.6		TOTAL EMISSIONS =	459.00
1	0.53000E 03	0.26999E 03	0.26913E-01	0.26912E 03	0.26912E 03
2	0.45000E 03	0.19973E 03	0.19075E-01	0.19075E 03	0.19075E 03
ASP = 30.00DEGREES,		WAVELENGTH BAND 1.8 - 2.7		TOTAL EMISSIONS =	2554.75
1	0.46290E 03	0.17408E 04	0.17410E 00	0.17410E 04	0.17410E 04
2	0.30000E 03	0.81300E 03	0.81375E-01	0.81374E 03	0.81374E 03
ASP = 30.00DEGREES,		WAVELENGTH BAND 3.9 - 4.8		TOTAL EMISSIONS =	1733.95
1	0.46290E 03	[illegible]243E 04	0.11240E 00	0.11244E 04	0.11244E 04
2	0.30000E 03	[illegible]900E 03	0.60951E-01	0.60954E 03	0.60954E 03
ASP = 30.00DEGREES,		WAVELENGTH BAND 4.2 - 4.3		TOTAL EMISSIONS =	162.67
1	0.46290E 03	0.10960E 03	0.10901E-01	0.10561E 03	0.10561E 03
2	0.30000E 03	0.57049E 02	0.57054E-02	0.57054E 02	0.57054E 02
ASP = 30.00DEGREES,		WAVELENGTH BAND 4.4 - 4.6		TOTAL EMISSIONS =	360.23
1	0.46290E 03	0.23304E 03	0.23300E-01	0.23300E 03	0.23300E 03
2	0.30000E 03	0.12715E 03	0.12710E-01	0.12710E 03	0.12710E 03
ASP = 170.00DEGREES,		WAVELENGTH BAND 1.8 - 2.7		TOTAL EMISSIONS =	569.[illegible]
1	0.	0.	[illegible]	0.	0.
2	0.21000E 03	0.56950E 03	[illegible]961E-01	0.56902E 03	0.56962E 03
ASP = 170.00DEGREES,		WAVELENGTH BAND 3.9 - 4.8		TOTAL EMISSIONS =	426.00
1	0.	0.	0.	0.	0.
2	0.21000E 03	0.42661E 03	0.42607E-01	0.42600E 03	0.42600E 03
ASP = 170.00DEGREES,		WAVELENGTH BAND 4.2 - 4.3		TOTAL EMISSIONS =	39.94
1	0.	0.	0.	0.	0.
2	0.21000E 03	0.39930E 02	0.39900E-02	0.39930E 02	0.39930E 02
ASP = 170.00DEGREES,		WAVELENGTH BAND 4.4 - 4.6		TOTAL EMISSIONS =	89.01
1	0.	0.	0.	0.	0.
2	0.21000E 03	0.89000E 02	0.89010E-02	0.89015E 02	0.89015E 02

ATTENUATED UNIT PARTS IN TOTALS

[illegible]

[illegible]

[illegible]

[illegible]

PIREP TEST PROBLEM 7
SPECTRAL SIGNATURE AND SPECIFIC MISSILES
CASE 2

PIRLP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 0. DEGREES
RANGE = 5000.00 FEET

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM 1.80 TO 2.70	MICRONS =	0.7257	WT/SR
FROM 3.90 TO 4.80	MICRONS =	0.5686	WT/SR
FROM 4.17 TO 4.25	MICRONS =	0.0476	WT/SR
FROM 4.40 TO 4.60	MICRONS =	0.4504	WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	1.0430	WT/SR
FROM 3.90 TO 4.80	MICRONS =	5.8848	WT/SR
FROM 4.17 TO 4.25	MICRONS =	0.5078	WT/SR
FROM 4.40 TO 4.60	MICRONS =	4.5150	WT/SR

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	2264.6422	WT/ST
FROM 3.90 TO 4.80	MICRONS =	1258.0987	WT/ST
FROM 4.17 TO 4.25	MICRONS =	9.3882	WT/ST
FROM 4.40 TO 4.60	MICRONS =	207.1352	WT/ST

```
                    PIREP TEST PROBLEM 7
                    SPECTRAL SIGNATURE AND SPECIFIC MISSILES
                                                           CASE   3

        PIREP EXTENSION STUDY

   ELEVATION ANGLE=  0.   DEGREES
   ASPECT RATIO =    1.00
   ASPECT ANGLE =    0.   DEGREES
   RANGE =        50000.00 FEET

    AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

              FROM 1.80 TO 2.70   MICRONS =          0.2740   WT/SR
              FROM 3.90 TO 4.80   MICRONS =          0.2496   WT/SR
              FROM 4.17 TO 4.25   MICRONS =          0.0652   WT/SR
              FROM 4.40 TO 4.60   MICRONS =          0.1328   WT/SR

    PLUME IR TOTALS

              FROM 1.80 TO 2.70   MICRONS =          0.4604   WT/SR
              FROM 3.90 TO 4.80   MICRONS =          0.6413   WT/SR
              FROM 4.17 TO 4.25   MICRONS =          0.0079   WT/SR
              FROM 4.40 TO 4.60   MICRONS =          0.4309   WT/SR

    ATTENUATED HOT PARTS IR TOTALS

              FROM 1.80 TO 2.70   MICRONS =        855.0206   WT/ST
              FROM 3.90 TO 4.80   MICRONS =        552.7515   WT/ST
              FROM 4.17 TO 4.25   MICRONS =          1.0778   WT/ST
              FROM 4.40 TO 4.60   MICRONS =         61.0724   WT/ST
```

PIREP TEST PROBLEM 7
SPECTRAL SIGNATURE AND SPECIFIC MISSILES
CASE 4

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 0. FEET

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM	1.80	TO	2.70	MICRONS	=	0.9185	WT/SR
FROM	3.90	TO	4.80	MICRONS	=	0.7251	WT/SR
FROM	4.17	TO	4.25	MICRONS	=	0.1371	WT/SR
FROM	4.40	TO	4.60	MICRONS	=	0.4263	WT/SR

PLUME IR TOTALS

FROM	1.80	TO	2.70	MICRONS	=	8.3132	WT/SR
FROM	3.90	TO	4.80	MICRONS	=	174.6405	WT/SR
FROM	4.17	TO	4.25	MICRONS	=	30.4460	WT/SR
FROM	4.40	TO	4.60	MICRONS	=	56.7684	WT/SR

ATTENUATED HOT PARTS IR TOTALS

FROM	1.80	TO	2.70	MICRONS	=	2268.0696	WT/ST
FROM	3.90	TO	4.80	MICRONS	=	1257.2842	WT/ST
FROM	4.17	TO	4.25	MICRONS	=	22.3034	WT/ST
FROM	4.40	TO	4.60	MICRONS	=	297.6496	WT/ST

PIREP TEST PROBLEM 7
SPECTRAL SIGNATURE AND SPECIFIC MISSILES
CASE 5

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 5000.00 FEET

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM 1.80 TO 2.70 MICRONS =	0.8055	WT/SR
FROM 3.90 TO 4.80 MICRONS =	0.5869	WT/SR
FROM 4.17 TO 4.25 MICRONS =	0.0683	WT/SR
FROM 4.40 TO 4.60 MICRONS =	0.5137	WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS =	4.8208	WT/SR
FROM 3.90 TO 4.80 MICRONS =	9.7619	WT/SR
FROM 4.17 TO 4.25 MICRONS =	1.5289	WT/SR
FROM 4.40 TO 4.60 MICRONS =	6.8767	WT/SR

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS =	1988.3616	WT/ST
FROM 3.90 TO 4.80 MICRONS =	1017.7415	WT/ST
FROM 4.17 TO 4.25 MICRONS =	11.1124	WT/ST
FROM 4.40 TO 4.60 MICRONS =	185.0670	WT/ST

PIREP TEST PROBLEM 7
SPECTRAL SIGNATURE AND SPECIFIC MISSILES
CASE 6

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 30.00 DEGREES
RANGE = 50000.00 FEET

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM 1.80 TO 2.70	MICRONS =	0.3052	WT/SR
FROM 3.90 TO 4.80	MICRONS =	0.2517	WT/SR
FROM 4.17 TO 4.25	MICRONS =	0.0055	WT/SR
FROM 4.40 TO 4.60	MICRONS =	0.1385	WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	2.1578	WT/SR
FROM 3.90 TO 4.80	MICRONS =	0.7659	WT/SR
FROM 4.17 TO 4.25	MICRONS =	0.0113	WT/SR
FROM 4.40 TO 4.60	MICRONS =	0.5236	WT/SR

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	753.2820	WT/ST
FROM 3.90 TO 4.80	MICRONS =	436.3955	WT/ST
FROM 4.17 TO 4.25	MICRONS =	0.8982	WT/ST
FROM 4.40 TO 4.60	MICRONS =	49.8961	WT/ST

PIREP TEST PROBLEM 7
SPECTRAL SIGNATURE AND SPECIFIC MISSILES
CASE 7

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 170.00 DEGREES
RANGE = 0. FEET

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM 1.80 TO 2.70 MICRONS =	0.9055	WT/SR
FROM 3.90 TO 4.80 MICRONS =	0.7278	WT/SR
FROM 4.17 TO 4.25 MICRONS =	0.1408	WT/SR
FROM 4.40 TO 4.60 MICRONS =	0.8322	WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS =	2.8872	WT/SR
FROM 3.90 TO 4.80 MICRONS =	60.6520	WT/SR
FROM 4.17 TO 4.25 MICRONS =	12.2827	WT/SR
FROM 4.40 TO 4.60 MICRONS =	17.4096	WT/SR

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS =	495.9608	WT/ST
FROM 3.90 TO 4.80 MICRONS =	310.5170	WT/ST
FROM 4.17 TO 4.25 MICRONS =	5.6238	WT/ST
FROM 4.40 TO 4.60 MICRONS =	74.0816	WT/ST

PIREP TEST PROBLEM 7
SPECTRAL SIGNATURE AND SPECIFIC MISSILES
CASE 8

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 170.00 DEGREES
RANGE = 5000.00 FEET

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM 1.80 TO 2.70 MICRONS =	0.7955	WT/SR
FROM 3.90 TO 4.80 MICRONS =	0.5875	WT/SR
FROM 4.17 TO 4.25 MICRONS =	0.0696	WT/SR
FROM 4.40 TO 4.60 MICRONS =	0.5154	WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70 MICRONS =	1.7277	WT/SR
FROM 3.90 TO 4.80 MICRONS =	3.1410	WT/SR
FROM 4.17 TO 4.25 MICRONS =	0.0706	WT/SR
FROM 4.40 TO 4.60 MICRONS =	2.2271	WT/SR

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70 MICRONS =	435.6969	WT/ST
FROM 3.90 TO 4.80 MICRONS =	250.6656	WT/ST
FROM 4.17 TO 4.25 MICRONS =	2.7802	WT/ST
FROM 4.40 TO 4.60 MICRONS =	45.8746	WT/ST

PIREP TEST PROBLEM 7
SPECTRAL SIGNATURE AND SPECIFIC MISSILES
CASE 9

PIREP EXTENSION STUDY

ELEVATION ANGLE= 0. DEGREES
ASPECT RATIO = 1.00
ASPECT ANGLE = 170.00 DEGREES
RANGE = 50000.00 FEET

AVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY

FROM 1.80 TO 2.70	MICRONS =	0.3009	WT/SR
FROM 3.90 TO 4.80	MICRONS =	0.2517	WT/SR
FROM 4.17 TO 4.25	MICRONS =	0.0055	WT/SR
FROM 4.40 TO 4.60	MICRONS =	0.1388	WT/SR

PLUME IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	0.7719	WT/SR
FROM 3.90 TO 4.80	MICRONS =	0.2470	WT/SR
FROM 4.17 TO 4.25	MICRONS =	0.0035	WT/SR
FROM 4.40 TO 4.60	MICRONS =	0.1653	WT/SR

ATTENUATED HOT PARTS IR TOTALS

FROM 1.80 TO 2.70	MICRONS =	164.8217	WT/ST
FROM 3.90 TO 4.80	MICRONS =	107.4119	WT/ST
FROM 4.17 TO 4.25	MICRONS =	0.2213	WT/ST
FROM 4.40 TO 4.60	MICRONS =	12.3516	WT/ST

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LOCKON RANGE, FEET

* *

ASPECT ANGLE (DEG)	MISSILE NUMBER 1	2	3	4
0.	14127.	49095.	41639.	113245.
30.00	14005.	45743.	39686.	104718.
170.00	8819.	27538.	21847.	61089.

APPENDIX B

FLOW CHARTS FOR PIREP SUBROUTINES

(EXTRAC(S)

```
**XEQ
       DATA CASE/1./
       V19=0.
       PAMB=14.7
       XM=0.
       END=0.
       NAMELIST/CYCLE/T7,T5,PBQAMB,AB,V19,PAMB,TAMB,XM,END
     * ,CASE,PB,ALT,FAR

   5   READ (5,CYCLE)
       IF(CASE.LT.0.) STOP
       CALL PIREP(T7,T5,AB,PB,PAMB,TAMB,V19,XM,ALT,FAR,
     * PCIR1,PCIR2,CIR1,CIR2,END)
       IF(END.EQ.99.) STOP
 2000  FORMAT(1H1,2X,8HCASE NO.,F7.1//2X,
     * 2HT7,8X,F8.2,8X,
     * 2X,2HT5,8X,F8.2/2X,4HP8,4X,F8.2,10X,2HA8,8X,F8.2/
     * 2X,4HPAMB,5X,F8.2,10X,2HXM,8X,F8.2/2X,4HV19,5X,F8.2)
       WRITE(6,2000)CASE, T7,T5,PB,    AB,PAMB,XM,V19
 1000  FORMAT(//20X,10HIR INDICES//
     * 15X,3H1.8-2.7,4X,7H3.9-4.3//
     * 2X,5HPLUME,2X,2F12.0/
     * 2X,7HHOT PTS,2F12.0)
       WRITE(6,1000)PCIR1,PCIR2,CIR1,CIR2
       CASE=CASE+1.

       GO TO 5

       END
```


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(ENTRANCE)

```
**PIREP
      SUBROUTINE PIREP(T7,T5,A8,P8,PAMB,TAMB,V19,XM,ALT,FAR,PC1R1,PC1R2,
     *C1R1,C1R2,END)
      COMMON/PREP/F9,TS,PC(6),P8QAMB,ENDA
      COMMON/INSET/SA(10)
      DIMENSION W(2),DEL(2),G(3)
      EQUIVALENCE(F9,A988)
      DATA W/1.8,3.9/,DEL/.390,.09/,C1/76805.4/,C2/25886./
      VE=XM*SQRT(2402.8*TAMB)+5.
      P8QAMB=P8/PAMB
      PR=P8QAMB**.25
      F9=1.
      IF(P8QAMB.GT.1.85) F9=.258*P8QAMB**0.875/(PR-1.)**.5
      TS=T7/PR
      CA=C2/TS
      CB=C1/3.*A8
C
C        NOTPARTS
C
```

```
      DO 110 L=1,2
```

```
      C1R2=0.
      DLL=DEL(L)
      SW=W(L)
      CX=CA/SW
      IF(CX.LT.88.)CX=EXP(CX)
      G(3)=CB/SW**5./(CX-1.)
```

```
      DO 100 J=1,5
```

```
      G(1)=G(3)
```

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```
      DO 90 M=2,3

      SW=SW*DLL
      CX=CA/SW
      IF(CX.LT.88.)CY=EXP(CX)

   90 G(M)=CB/SW**5./(CY-1.)

  100 CIR2=CIR2+DLL*(G(1)+4.*G(2)+G(3))

  110 IF(L.EQ.1) CIR1=CIR2

C               PLUME

      S1=ALLG(TS)
      S2=ALLG(PBOAMB)
      S3=ALLG(F9*AB)
      S4=ALLG(VE)
      S5=ALLG(PAMB)
      S6=ALLG(PR-1.)
      S7=ALLG(V19+5.)

C                1.8 - 2.7

      PCIR1=  2.642*S1 + 0.692*S2 +
     *        1.286*S3 + 0.0667*S4 +
     *        0.836*S5 - 0.1245*S6 -
     *        7592./TS - 19.766
      IF(PCIR1.GT.88.) PCIR1=-80.
      PCIR1=EXP(PCIR1)

C                4.0 - 4.8

      PCIR2=  1.2185*S1 + 0.712*S2 +
     *        1.205 *S3 + 0.0606*S4 +
     *        0.367 *S5 - 0.1595*S6 -
     *        6675./TS - 8.196  +.023*S7
      IF(PCIR2.GT.88.) PCIR2=-80.
      PCIR2=EXP(PCIR2)
```

```
      IF(END.NE.99)GO TO 900

      PC(1)=PCIR1
      PC(2)=PCIR2
      PC(3)=CIR1
      PC(4)=CIR2
      AA(1)=T7
      AA(2)=T5
      AA(3)=A8
      AA(4)=P8
      AA(5)=PAMB
      AA(6)=TAMB
      AA(7)=V19
      AA(8)=XM
      AA(9)=ALT
      AA(10)=FAR
      ENDA=END
      CALL PLOCK

  900 RETURN

      END
```

```
                    (ENTRAL)
                       I
                       I
********************************************************
**ALLG                                                 *
*       FUNCTION ALLG(A)                               *
*       ALLG=0.                                        *
*       IF(A.GT.0.) ALLG=ALOG(A)                       *
********************************************************
                       I
                       I
                       I
********************************************************
*       RETURN                                         *
********************************************************

********************************************************
*       END                                            *
********************************************************
```

```
                                (ENTRANCE)
                                    I
                                    I
***********************************************************************
**PLOCK                                                               *
**PLOCK                                                               *
*        S[illegible] PLOTK                                           *
*        COMMON/[illegible](10),FMS(8),TR(10))                        *
*        COMMON/P[illegible]/[illegible],TS,PCIR1,PCIR2,CIR1,CIR2,PR3AMB,FNO *
*        COMMON/[illegible]/NSP[illegible],ANT(7),ANE(7)              *
*        COMMON/LOCK/JS4S(5),SN(5),NEI(5),N1,N2,RANGE(5)              *
*       *,LA(7),IR,PM[illegible](5,10)                                *
*        COMMON/ENVIR/OA,TA(5),DA(5),XHA(5),PA(5),THT,RH,ALT          *
*        COMMON/TTAL/[illegible](7,10),HPTOT(7,10),IAA                *
*        COMMON/[illegible]/[illegible]P,AA(1000)                     *
*        DIMENSION THTA(5)                                            *
*        DIMENSION SNH(7),ANEI(2),ASPI(5),HTOT(7)                     *
*        COMMON/PLUME/FAR,IA,AXI,TR(7),FIRST,PC1,PC2,NTR,SA,SS,       *
*       + [illegible]T,SPEC,IE                                        *
*        DIMENSION MX(2)                                              *
*        COMMON/CNT/N,BES,DUM(10),NAS                                 *
*        REAL [illegible]                                             *
*         COMMON/INSET/T7,[illegible]5,A8,P8,PAM3,CAM8,V19,XM,ALTI,FAR8 *
*        DIMENSION [illegible]CM(20)                                  *
*        DATA [illegible]/1/,NLOCK/1/,SUR/[illegible].7/,ANEI/2.E-10,4.E-11/ *
*        DATA [illegible]/0.0/,SPEC/0./,THTA/0.,4*9999./,AXI/1./,NNX/0/ *
*        DATA ASPI/1.,4*9999./,CASE/1./                               *
*                                                                     *
*C          PRINT IR NUMBERS                                          *
*                                                                     *
*        READ (5,2050) (NCM(I),I=1,20)                                *
*        WRITE(6,2100) (NCM(I),I=1,20),NPG                            *
* 2100    FORMAT(1H1,2(10A6/),50X,4HCASE,I4//)                        *
* 2050    FORMAT(10A6)                                                *
* 2000    FORMAT(2[illegible],13H** PIRCP OUTPUT **//2X,              *
*       + 2HT7,4X,F8.2,2HK,                                           *
*       + 2X,2H75,3X,F8.2/2X,6HP8     ,4X,F8.2,10X,2HA8,8X,F8.2/      *
*       + 2X,4HPAM3,6X,F8.2,10X,2HXM,8X,F8.2/2X,4HVC19,6X,F8.2,       *
*       + 10X,4HALTI,7X,F8.2/2X,3HFAR,7X,F8.2)                        *
*        WRITE(6,2000) T7,T5,P8,A8,PAM4,XM,V19,ALTI,FAR8              *
* 1050    FORMAT(//20X, [illegible]IR INDICES//                       *
*       + 15X,[illegible]1.8-2.7 ,4X,[illegible]5.9-4.8//             *
*       + 2X,[illegible]ME,2X,2F12.0/                                 *
*       + 2X,7H[illegible] PTS,2F12.0)                                *
*        WRITE(6,1050) PCIR1,PCIR2,CIR1,CIR2                          *
*                                                                     *
*C          INITIALIZE                                                *
*                                                                     *
*        HTS=9999.                                                    *
*        DATA COR/57.29/                                              *
*        ALT=[illegible]                                              *
*        FAR=FAR8                                                     *
*        DATA FIRST/0./                                               *
*        TA(1)=TAMB                                                   *
*        KH=0.                                                        *
***********************************************************************
                                    I
```


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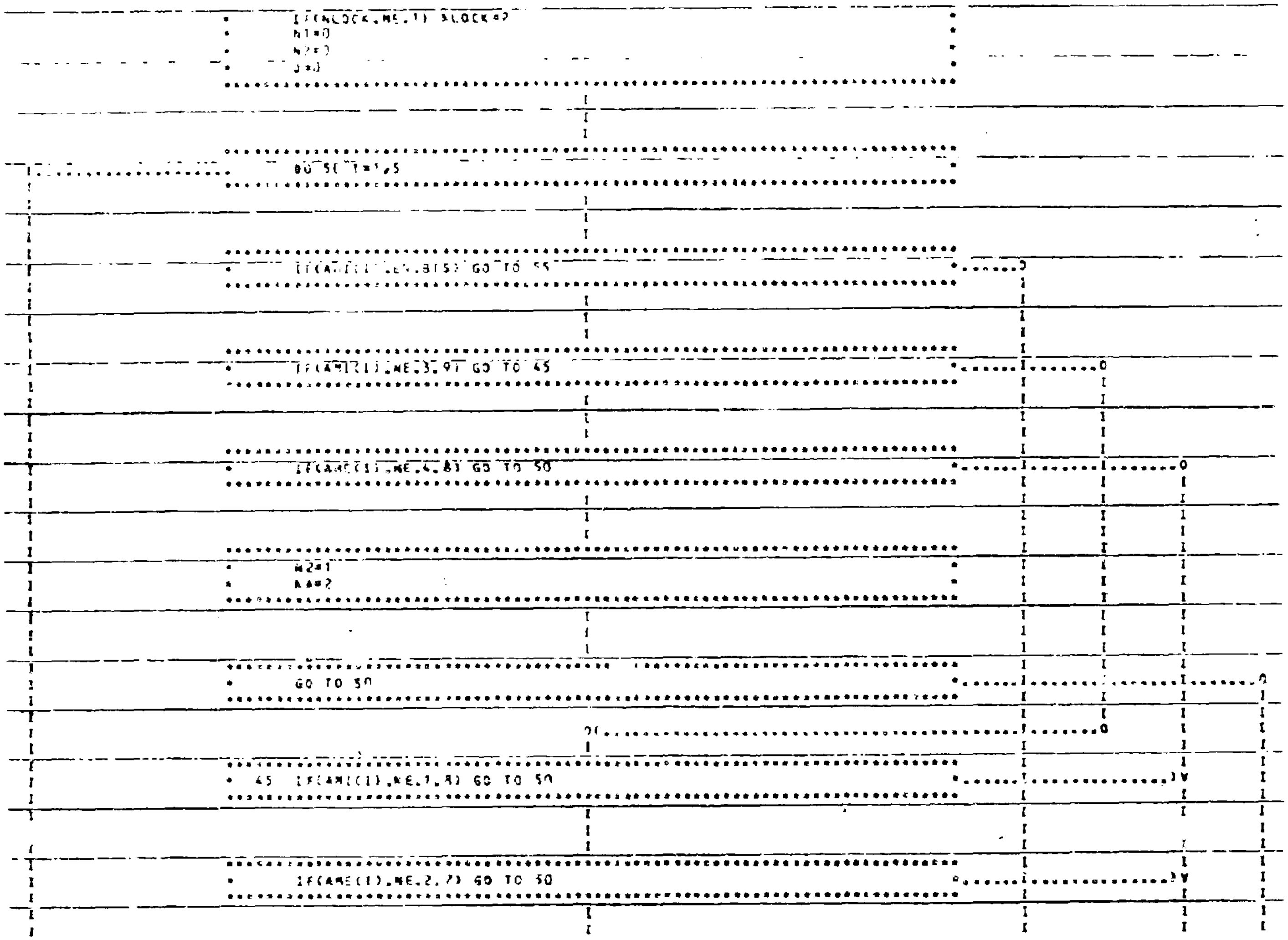
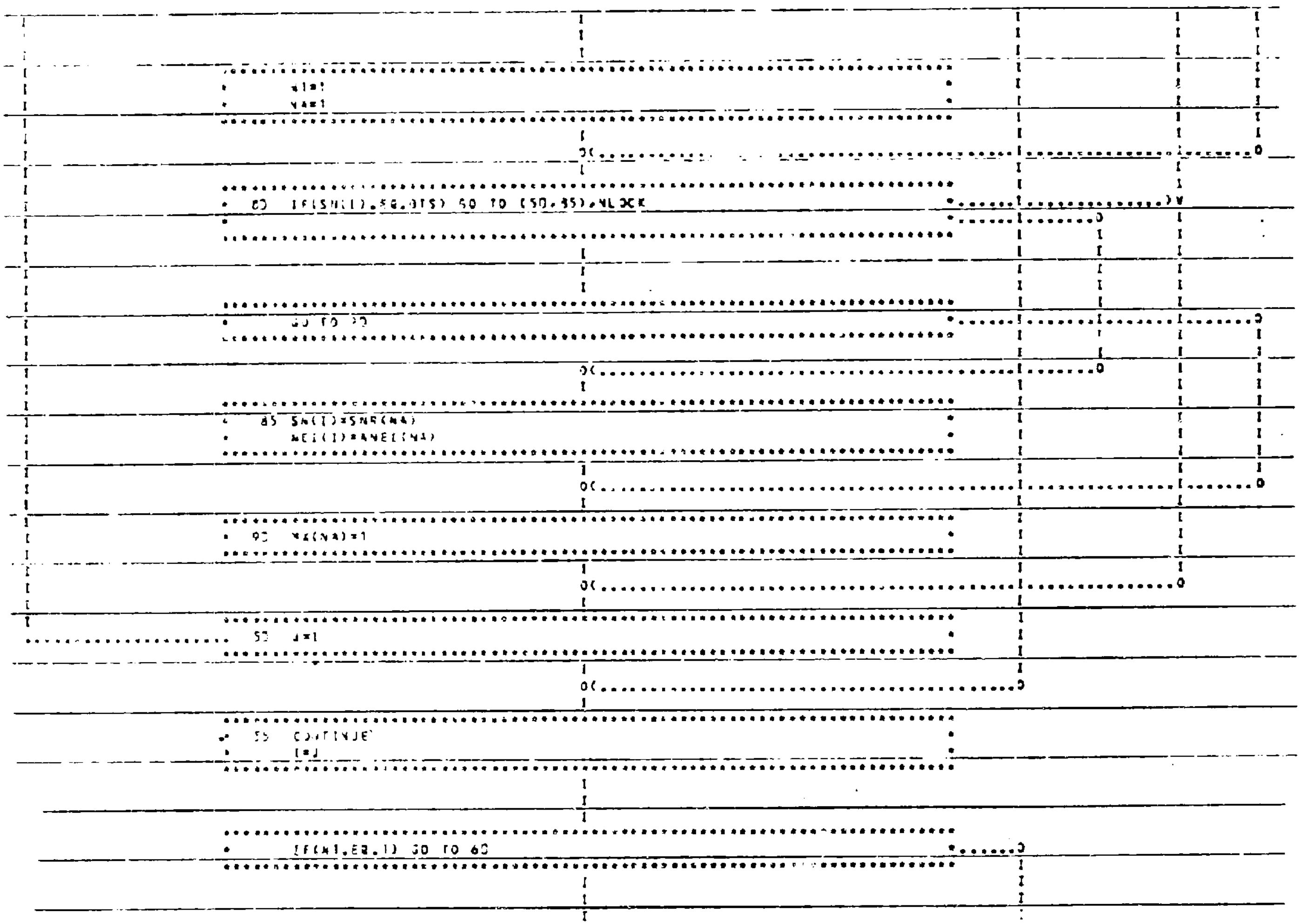
```
      IF(CASE.NE.1.) GO TO 10

      CASE=2.

      DO 5 I=1,7

      AMI(I)=BTS
      AME(I)=BTS
       SA(I)=BTS
      BS.S(I)=1.0
      ASP(I)=BTS
      LA(I)=I

      IF(I.GT.5) GO TO 5

      ASP(I+5)=HTS
      RANGE(I)=BTS

    5 CONTINUE
      VR=10.

   10 CONTINUE
      NAMELIST/INPUT/ASP,RANGE,THT,AMI,AME,SPEC,
     + BSAS,SA,PEI,RH,ALT,FAR,THTA,ASPI,
     + NLOCK,NE
      READ(5,INPUT)

      IE=0
```


IF(NLOCK.NE.1) NLOCK=2
N1=0
N2=0
J=0
DO 50 I=1,5
IF(AME(I).LE.BES) GO TO 55
IF(AME(I).NE.3.9) GO TO 45
IF(AME(I).NE.4.8) GO TO 50
N2=1
KA=2
GO TO 50
45 IF(AME(I).NE.1.8) GO TO 50
IF(AME(I).NE.2.7) GO TO 50



N1=1
NA=1
80 IF(SN(I).EQ.DTS) GO TO (50,85),NLOCK
GO TO
85 SN(I)=SNR(NA)
NEI(I)=ANEI(NA)
90 NA(NA)=1
50 J=1
55 CONTINUE
I=J
IF(N1.EQ.1) GO TO 60

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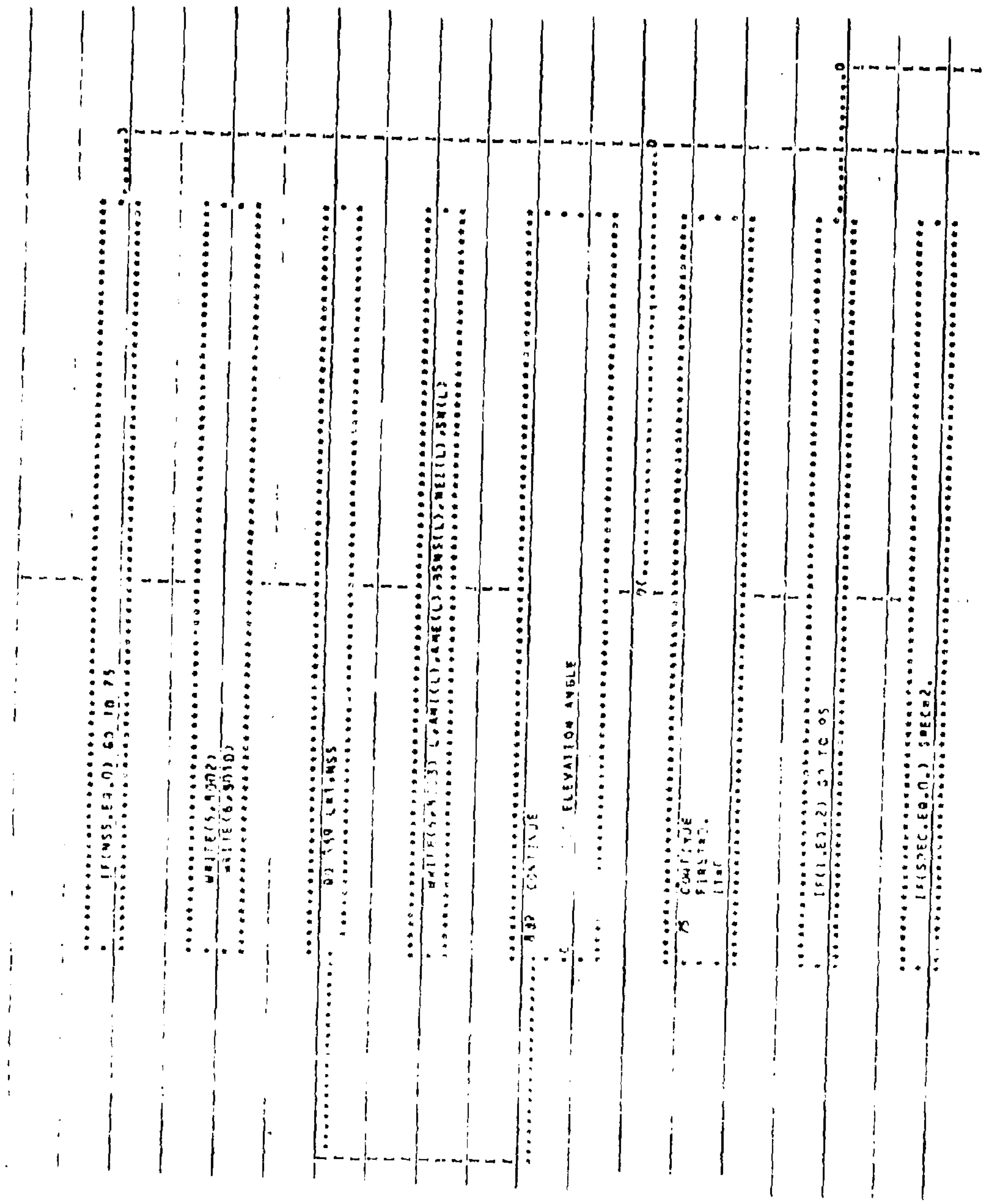
```
      I=I+1
      ANI(I)=1.8
      ANE(I)=2.7
      NA=1

      GO TO (60,65),NLOCK

   65 SA(I)=SAR(NA)
      NEI(I)=ANEI(NA)
      NX(NA)=1

      GO TO (60,70),NA

   60 IF(N2.EQ.1) GO TO 70

      I=I+1
      AMI(I)=3.9
      AME(I)=4.8
      NA=2

      GO TO (70,65),NLOCK

   70 NSPEC=I
      N1=1-NX(1)
      N2=1-NX(2)
 8002 FORMAT(////1X,20(2H *),///15X,13HMISSILE PARAMETERS//
     + 1X,20(2H *)///7X,3HNO.,2X,13HWAVELENGTH BAND,
     + 5X,11HSENSITIVITY,7X,3HNEI,5X,3HS/N//)
 8010 FORMAT(15X,9H(MICRONS),20X,13H(WATTS/CM**2)//)
 8003 FORMAT(I9,F7.1,2H -,F4.1,F16.1,E15.4,F7.1)
      NSS=NSPEC-N1-N2
```



IF(NSS.EQ.0) GO TO 75
WRITE(5,9002)
WRITE(6,9010)
DO 339 L=1,NSS
WRITE(5,9013) L,ANI(L),ANE(L),BSNS(L),NEI(L),SN(L)
339 CONTINUE
ELEVATION ANGLE
75 CONTINUE
FIRST=0.
IF(I.EQ.2) GO TO 95
IF(SPEC.EQ.0.) SPEC=2.

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```
95  CONTINUE
    ...=...(IT)

IF(HT.EQ.HTS.OR.IT.EQ.6) GO TO 9999

C         SELECT ASPECT RATIO

     IX=1

109  AX=ASPR(IX)

IF(AX1.EQ.HTS.OR.IX.EQ.6) GO TO 95

C         SELECT ASPECT ANGLE

     IA=1

100  AN=ASP(IA)

IF(ANG.EQ.HTS.OR.IA.EQ.IT) GO TO 905
```

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```
      IF(ANG.GT.90.) ANG=180.-ANG
      IF(ANG.LT.5.) ANG=5.
      SS=SIN(ANG/C9R)
      CS=COS(ANG/C9R)
      SA=1./SS
      IF(ASP(IA).GT.20.) SA=CS

C          SELECT RANGE

      IR=1

  105 IF(RANGE(IR).EQ.RTS.OR.IR.EQ.5) GO TO 907

      WRITE(5,7000) (NCM(I),I=1,20),NPG
      NPG=NPG+1
      WRITE(5,3000)
 8000 FORMAT(10X,21HPIREP EXTENSION STUDY//)
      WRITE(5,3001) THI,AXI,ASP(IA),RANGE(IR)
 8001 FORMAT(2X,16HELEVATION ANGLE=,F5.1,8H DEGREES/
     + 2X,16HASPECT RATIO =,F7.2/
     + 2X,16HASPECT ANGLE =,F7.2,8H DEGREES,
     + 2X,7HRANGE =,F16.2,5H FEET)
      AX1=1.
      AX2=1.
      KTR=2

      IF(RANGE(IR).EQ.0.) GO TO 120

      KTR=1

      IF(SPEC.NE.0..AND.RANGE(1).EQ.0.) GO TO 120
```

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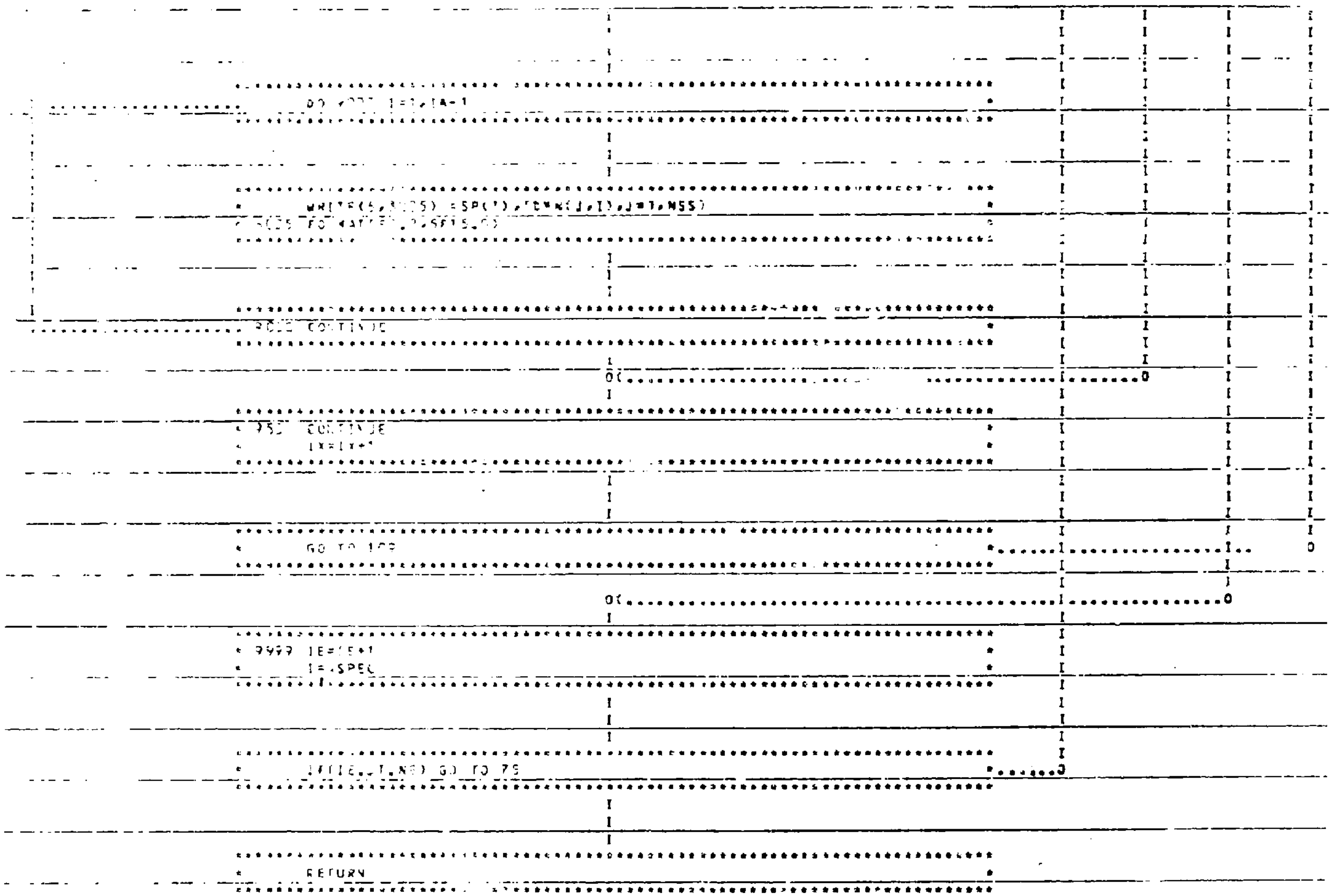
```
C       COMPUTE RANGE TRANSMISSION

        R1=R2
        R1=.4-GET(R)/1000.+.35
        R2=(R3+.1875/RG)
        RX1=RX2**(-4.6/RG**.2/(177/100(D.)**.75)
        RX2=RX2**(-3**2./177/SG**.13)

 20     FC1=FC1F1*RX1*SS
        FC2=FC1F2*RX2*SS

        IF(AXI.EQ.1..OR.AIR.EQ.1) GO TO 110

C       EVALUATE FOR RECTANGULAR NOZZLE

 115    CALL GLENN(AXI,THT,F1,F2)
        FC1=FC1*F1
        FC2=FC2*F2

 110    IF(SPEC.EQ.0.) GO TO 560

        CALL PLUMEX

        GO TO 570
```

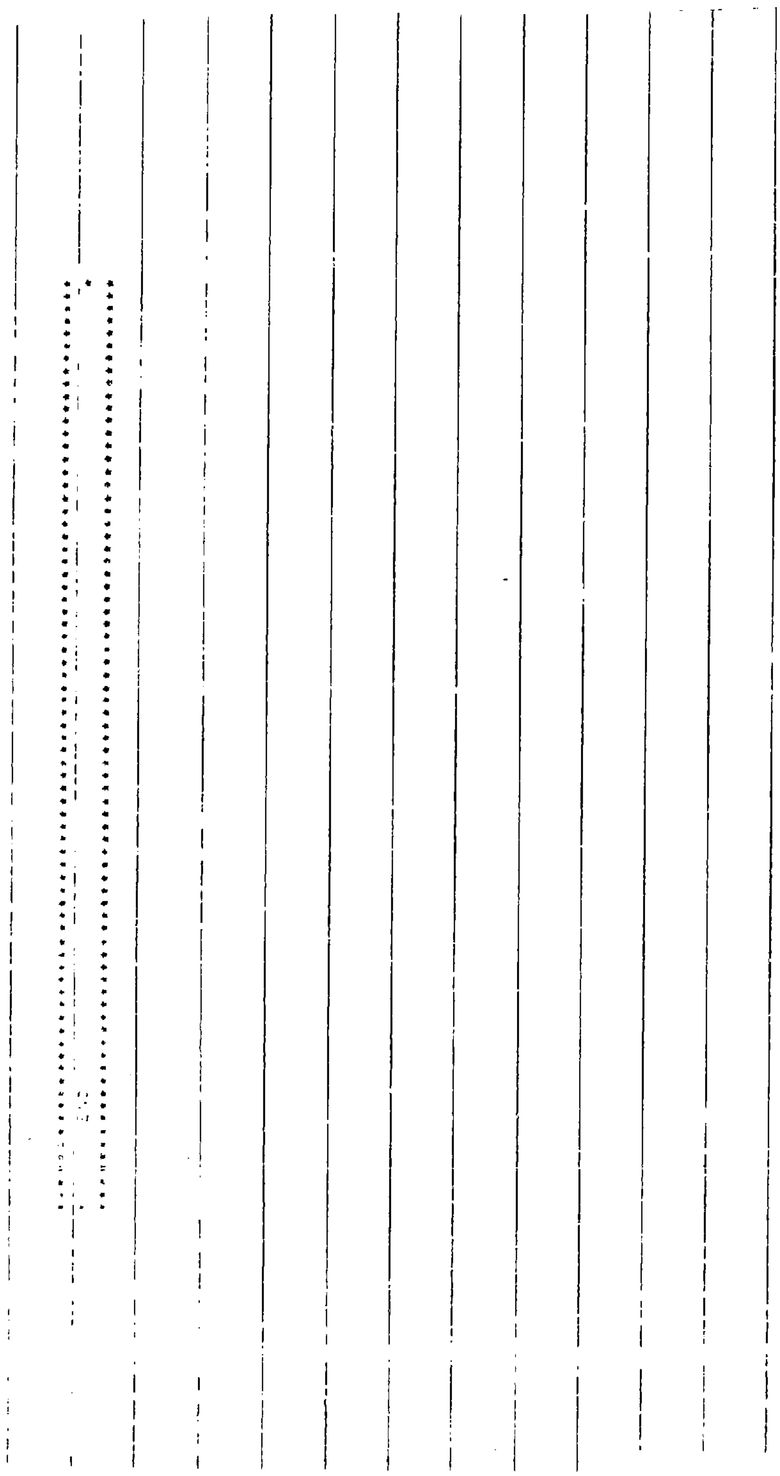
```
  560   PTOT(1)=PC1
        PTOT(2)=PC2

  570   CONTINUE

        IF(FIRST.NE.0.) GO TO 700

C       EVALUATE HOT PARTS

        CALL HAINE

  700   CONTINUE

        IF(SPEC.NE. [illegible] GO TO 750

        [illegible]
        WRITE(6,2700)
        WRITE(6,2900) (AME1(I),AME(I),PTOT(I),I=1,NSPEC)
  2700  FORMAT(//3X,15HPLUME IR TOTALS//)
        IR=21 [illegible]

        IF(RANGE(IR).EQ.0.) GO TO 7A0
```

```
DI=AL[illegible](PR[illegible]ANS[illegible](18)/2[illegible]).
[illegible]=[illegible]
[illegible]=[illegible]
[illegible]=1).[illegible] TR(1)=1.
IF(TR(2)).[illegible] TR(2)=1.
IF(TP(1).GT.1.) TP(1)=1.
IF(TP(2).GT.1.) TP(2)=1.

750 IF(IS.LT.4) GO TO 757

DO 755 I=1,ISPEC

IF(AMF(I).GT.2.7) GO TO 757

AL=AMF(I)-2.7
IF(AL.LT.0.) AL=1.5-AMF(I)

IF(AL.LT.0.) GO TO 755

AL=AL/(AMF(I)-AM(I))
IF(AL.GT.1.) AL=1.
TR(I)=TR(I)*(AL+(1.-AL)*TM(IA))
```

```
  750  CONTINUE

  780  CONTINUE

C         ATTENUATE HOT PARTS AND TOTAL

          IF(VAS.GE.IA) WRITE(6,2800)
  2800  FORMAT(//5X,32HATTENUATED HOT PARTS IN TOTALS//)

          DO 705 I=1,NSPEC

          IF(VAS.GE.IA) GO TO 710

          HTOT(I)=0.

          GO TO 705

  710     HTOT(I)=TR(I)*HPTOT(I,IA)
          WRITE(6,2900) AM1(I),AME(I),HTOT(I)
  2900  FORMAT(12X,4HFROM,F5.2,3H TO,F5.2,11H  MICRONS =,F12.4,
        * 7H  W/ST)

  705     HTOT(I,IR)=HTOT(I)+PTOT(I)
          FIRST=1.
          IR=IR+1
```

```
      GO TO 105

C     COMPUTE LOCKON RANGE

 700  CONTINUE
      IAAGIA
      IF(ISSUFE.) CALL MAIN
      IAAIA+1

      GO TO 100

 935  CONTINUE

      IF(NSS.EQ.0) GO TO 950

C     WRITE LOCKON SUMMARY

 8036 FORMAT ///20X,30(2H *)///20X,
     + 10X,15HLOCKON RANGE, FEET//20X,30(2H *)//
     + 2X,6HASPECT/3X,5HANGLE,16X,15HMISSILE  NUMBER/
     + 3X,5H DEG),I12,6I15//)
      WRITE(6,8036) (I,I=1,NSS)
```


I=1,IA-1
WRITE(5,) ESP(I),(DMN(J,I),J=1,NSS)
FORMAT
CONTINUE
CONTINUE
IX=IX+1
GO TO
9999 IE=IE+1
I=ISPEC
GO TO 75
RETURN

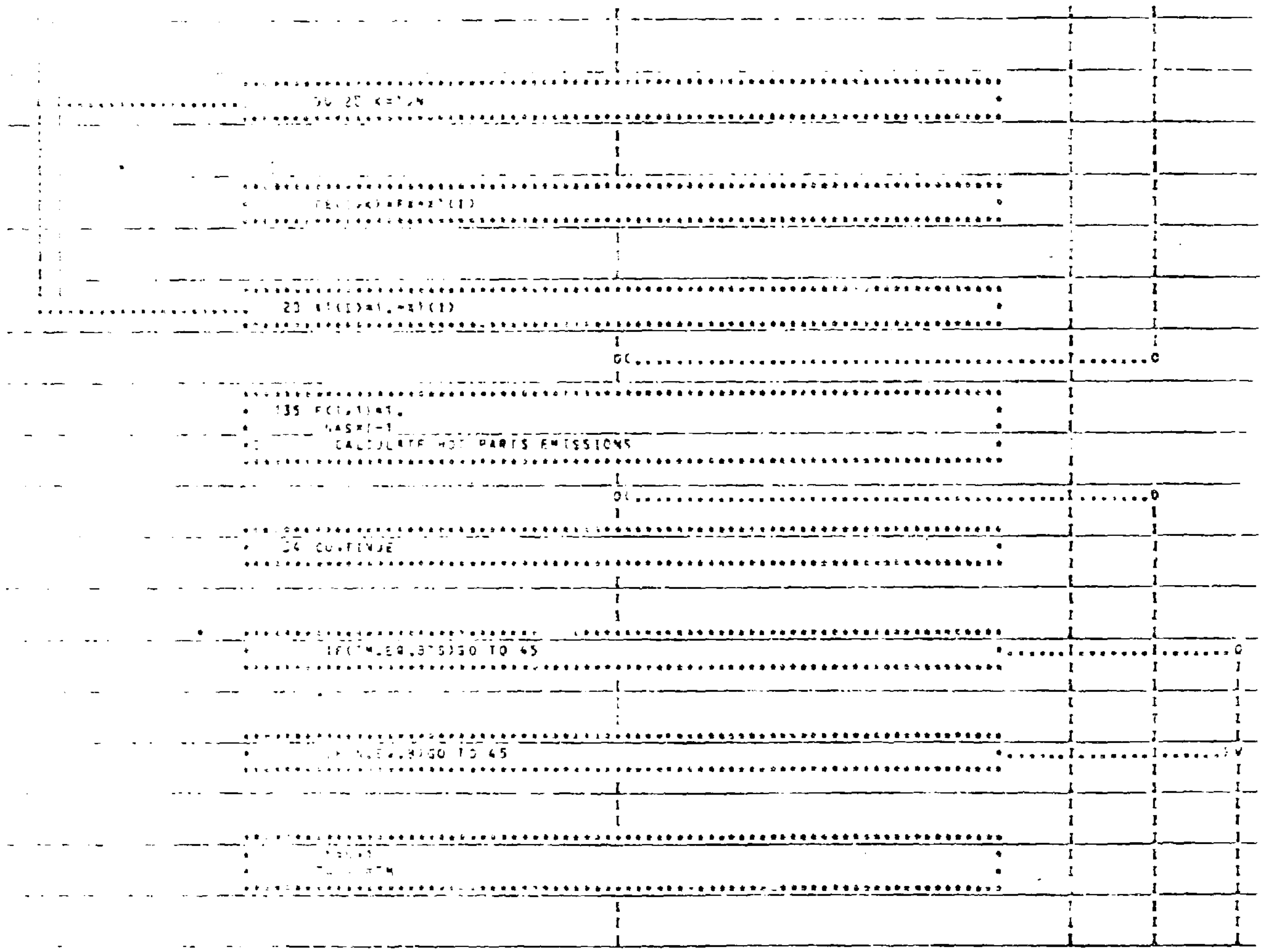


```
(ENTRANCE)
    I
    I
GLEHN
      SUBROUTINE GLEHN(AXI,IHF,F1,F2)
      COMMON/IP SET/... (7),EXM,ALTI,FAR
      DIMENSION Y(5,4),XM(5),F(14)
      DATA XM/1.,3.,6.,10.,17./
      DATA F/F,7/
      DATA Y/
     * 1.,.67,.4,.2,.1,
     * 1.,.74,.53,.39,.26,
     * 1.,.65,.38,.22,.125,
     * 1.,.76,.54,.39,.29/
      GROUND/ROUND                 1.8-2.7
                                   3.9-4.5
      NARROW/BROAD                 1.8-2.7
                                   3.9-4.5
      AX=AXI
      FIF=EXF
      IF(IXM.EQ.0.) FXF=1.
      IF(AXI.LT.1.) AX=1./AX
    I
    I
      DO 20 I=2,4
    I
      IF(AX.LT.XM(I)) GO TO 30
    I
 20   CONTINUE
      I=5
    I
   30
    I
 30   AC=(AX-XM(I))/(XM(I)-XM(I-1))
      AD=1.-AC
    I
    I
      DO 40 J=1,4
    I
```

```
40    A(J)=XX(I-1,J)*AC+XX(I,J)*AD
      TH=ABS(T-T)
      IF [illegible](I.LT.1.) TH=90.-TH
      CS=COS(TH/57.296)
      F1=F(1)*(CS+(1.-CS)*F(2))
     * *F[illegible]
      F2=F(3)*(CS+(1.-CS)*F(4))
     * *F[illegible]

      RETURN

      END
```

```
(E  RANCE)

SUBR    TINE MAINF
C     /T  X/T (  ),THA(10),EMS(8)
         SFT/T ,  ,AK,PB,PAMB,TAMB,V10,  ,ALTI,FAR
      N    CONT/  ,   FC,MAS
COMMON/S   /X1(  ),Y1(8),X2(8),Y2(8),VFCT(8),
* ISURF(8),NODE(8),XF(2),NTOT1,NP(2),AREA(8)
* ,F(8,8),XC(8),YC(8)
DIMENSION AH(8)
DI    SION FE(  ,8)
DATA AREA/8*1./
DATA  OR/57.296/

DO 150 K=1,8

  S(K)=1.
TW(K)=BTS
AH(K)=BTS
 T(K)=TTS
NODE(K)=K

IF(K.GT.  ) GO TO 150

 C(K)=  S

150  X   =1.
     =
     M=  S
     NAMELIST/ENGINE/X1,Y1,XC,YC,TW,EMS
   * ,TM,E ,AR
     READ(5,ENGINE)
```

```
      IF(Y(?)...NE.BTS) GO TO 30

  800 FORMAT(1H1/20X,30HEXHAUST HOT PARTS INPUT/OUTPUT)
  BC(?  FORMAT(20X,3(E(24 *)//)

      IF(I*(?).EQ.HIS) GO TO 100

      N=2
      F(2,2)=1.
      F(1,2)=0.
      F(2,1)=0.

  100 CONTINUE
      IF(TS(?).EQ.BTS) T4(1)=TS

      DO 20 I=1,10

      IF(THA(I).GE.90.) GO TO 135

      F=AB*COS(THA(I)/COR)
```



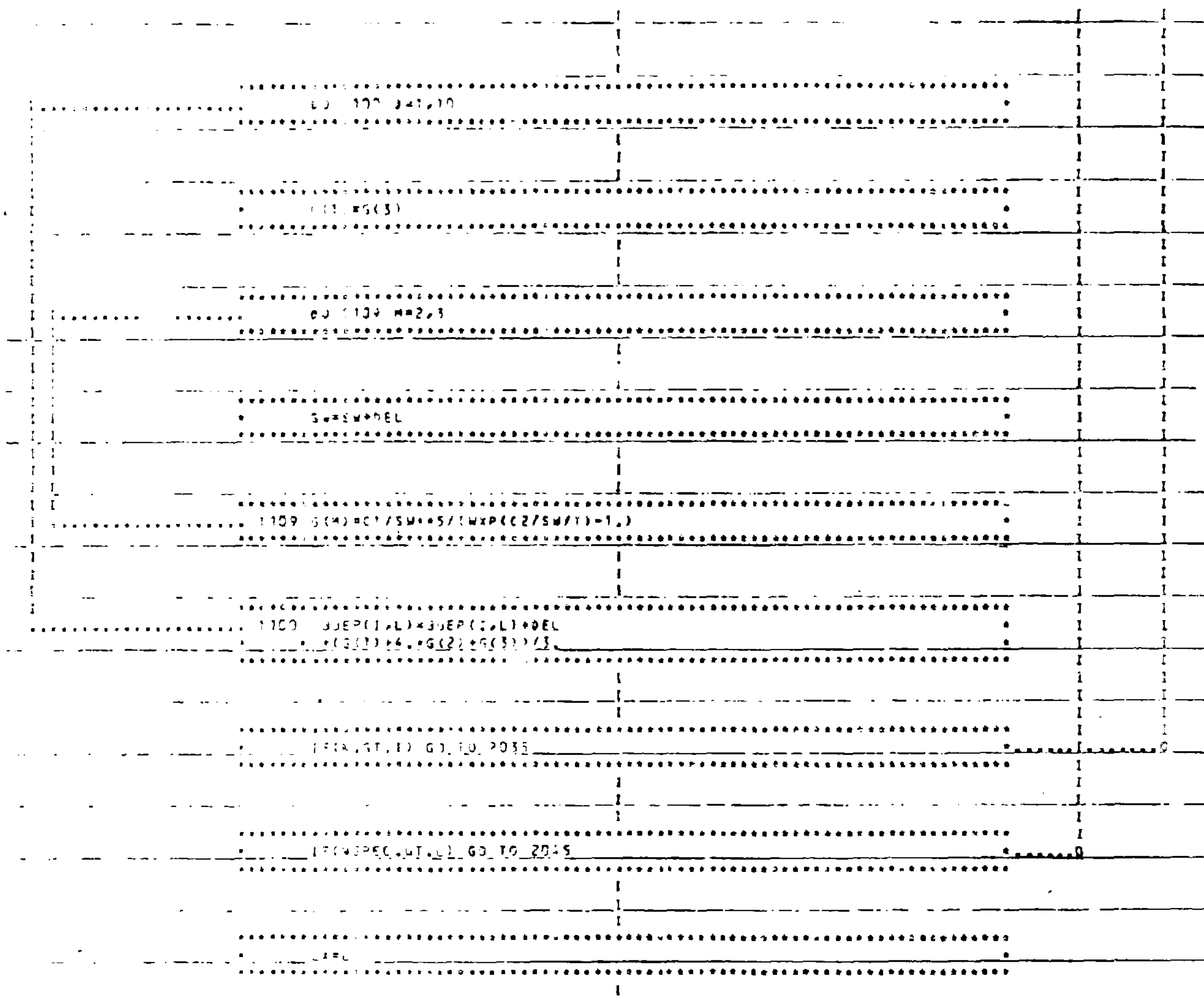
135 F(I,1)=1.
CALCULATE HOT PARTS EMISSIONS

```
      DO 75 I=1,N-1
      F(I,N)=0.
   75 F(N,I)=0.
      F(N,N)=1.
      DO 65 K=1,IAS
   65 FE(K,N)=AR(K)*EM
   50 IF(AR(NAS+1).EQ.BTS.OR.NAS.EQ.0.OR.THA(NAS+1).EQ.BTS)
     * GO TO 45
      NAS=NAS+1
      DO 45 I=1,N-1
   45 FE(NAS,I)=0.
      FE(NAS,N)=AR(NAS)*EM
```

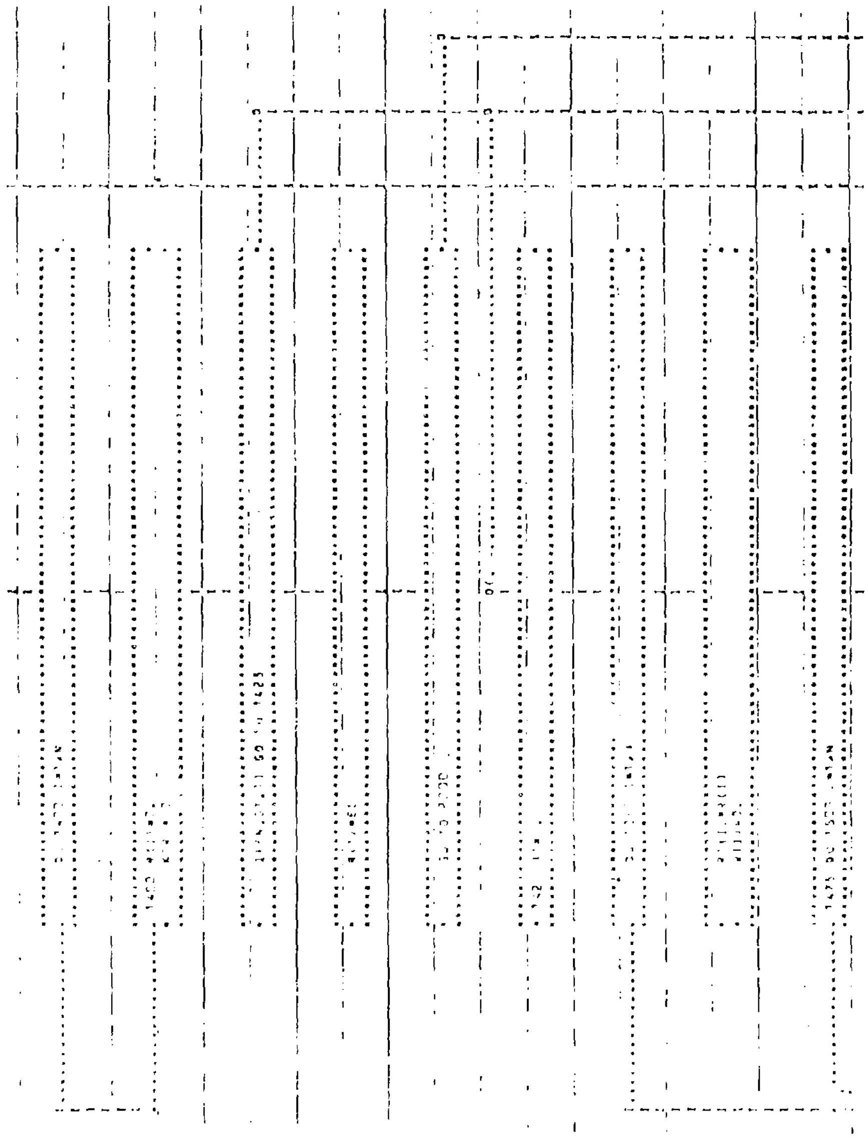
```
      GO TO 10

   45 CONTINUE
      IF(NSFL ...) RETURN
      WRITE(6,5000)
      WRITE(6,...)
      WRITE(6,8001) (THA(I),I=1,NAS)
      WRITE(6,8005)
 8005 FORMAT(1H0)

      DO 60 J=1,N

   60 WRITE(6,8002) J,T(J),(FE(K,J),K=1,NAS)
 8001 FORMAT(2X,4HNODE,2X,11HTEMPERATURE,10X,
     + 40HPROJECTED AREAS (IN2) AT EACH ASPECT ANGLE/
     + 1X,6HNUMBER,5X,5H(R),4X,10F8.1//)
 8002 FORMAT(I4,F10.1,4X,10F8.1/)
      WRITE(6,8009)
      CALL SIRFR(F,AREA,NODE,THA)

      RETURN

   20 CALL FXCX

      GO TO 1.
```

```
ENTRANCE

**SIHER
      SUBROUTINE SIHER([illegible]C,[illegible]SA,NODE,THA)
      COMMON/TWX/TW(8),THETA(10),EHS(8)
     *,[illegible])
      DIMENSION [illegible]A(10),AP(10,8),FFF(64),EPR(8),RR(8,5),RA(10,8)
     *,[illegible](7,5),[illegible]E(5),RO(5),E(7)
C
CSPECTRAL INFRARED RADIATION EMISSIOS AND REFLECTIONS
      [illegible]/[illegible]C,AMI(7),A4E(7)
      DIMENSION LOC(5),NODE(8)
     *,[illegible]7)
      COMMON/TTAL/ATOT(7,10),HPTOT(7,10)
      DIMENSION R(M),R(8),R1(8),RC(64),VCD(8),VC1(8),Y(8),XMC(8,8),
     *[illegible])
      [illegible]/[illegible]BTS,B2,KA
      DATA [illegible]5.47,C2/25884./
      [illegible]
C
      CHECK = 0.0
      XITUM=.01
      LIMIT = 50
32 [illegible] FORMAT (//,7X,7H [illegible] =,F8.2,9HDEGREES,
     * 5X,[illegible]WAVELENGTH BAND,F6.1,2H - F6.1,
     [illegible] TOTAL EMISSIONS =,F10.2//)
32[illegible] FORMAT(
     *///15X,20(2[illegible])/
     * 2X,4HNODE,[illegible]X,4HAREA, 11X,6HDIRECT,8X,9HREFLECTED,6X,9HRADIOSITY
     * [illegible]X,10HCUMULATIVE/26X,9HEMISSIONS,6X,9HEMISSIONS,20X,9HEMISSIONS/
     * 5X,12H(SQ.INCHES),12X,17H(WATTS/STERADIAN))
2[illegible]    FORMAT(
     * [illegible](I7,5E15.5/))
      IF(K.GT.1) WRITE(6,320[illegible])
      NT=1

      DO 205 I=1,N

      AREA=EB(I)
      F(I)=1.

      DO 600 J=1,N
```

```
      [illegible]
      R[illegible]=XMC(I,J)

      IF([illegible]) GO TO 900

      [illegible]M[illegible](I,J)=[illegible]C(I,J)+AR

  900 CONTINUE
      K[illegible]C(I,I)=[illegible]C(I,I)
      [illegible]=F(I)-[illegible]C(I,I)
      [illegible])=[illegible]

  905 CONTINUE
      L=0

 2045 CONTINUE
      L=L+1
      [illegible]=(AME(L)-AM[illegible](L))/20.
      I=[illegible]

 2035 CONTINUE
      I=I+1
      T=[illegible](I)
      [illegible]HEP(I,L)=0.
      [illegible]K(I,L)=0.
      S[illegible]=AM[illegible](L)
      [illegible](3)=C1/S[illegible]**5/(EXP(C2/S[illegible]/T)-1.)
```


SW=SW+DEL
1109 G(4)=C1/SW**5/(EXP((C2/SW/T))-1.)
GO TO 2035
GO TO 2045

```
DO 1150 MA=1,NA
DO 1150 I=1,N
1150  WRA(MA,I)=0.
1160  CONTINUE
DO 960 I=1,N
      EI=EMS(I)
      IF(EI.EQ.1.) EI=.9999
      RHO=(1.-EI)/AREA(I)
      XMC(I,I)=-(1./RHO+F(I)      )
      VCD(I)=EI/RHO
      E(I)=EI
960 CONTINUE
  COMPUTE REFLECTION COEFFICIENTS FOR EACH COMPONENT
      KO=1
      KO=K+1
1250 VC1(KO)=-VCD(KO)
```



```
1500 V(I)=V(I)+XMC(I,J)*B(J)
     C(I)=V(I)-XMC(I,I)*B(I)
1600 B(I)=(C(I)-V(I))/XMC(I,I)
     RY=B(I)+1.0E-10
     RX=C(I)+1.0E-10
     TEST =ABS(RY/RX-1.)-XITLM

1225 IF(TEST.GT.0.) AT=1.

     IF(AT) 2000,2030,1800

1800 IF(CHECK.EQ.0.0) GO TO 1850

1750 CONTINUE

1850 KTR=KTR + 1

     IF(KTR.LT.LIMIT) GO TO 1425

2000 VC1(KG)=C.
```

```
      DO 301 K=1,N
      DO 300 MA=1,NA
300   WRA(MA,KO)=WA(MA,KO)+R(K)*AP(MA,K)
      DO 301 L=1,LX
      WR(K,L)=RW(K,L)+BREP(KO,L)*R(K)
301   CONTINUE
      KO=KO+1
      IF(KO-N)1250,1250,2200
2200  MA=1
2250  L=1
```

```
2300 TDE=0.
     SUMWL=0.
     TB(MA)=0.
```

```
DO 2400 I=1,N
```

```
     EPR(I)=PR(I,L)*AP(MA,I)
     DE(I)=SBEFF(I,L)*AP(MA,I)*E(I)
     RO(I)=EPR(I)-DE(I)
     TEPRL=TEPRL+EPR(I)
     TDE=TDE+R(I)
     TB(MA)=TB(MA)+R(I)*TW(I)
2400 R(I)=AA(MA,I)*DHEP(I,L)
```

```
2402 CONTINUE
     TB(MA)=1.-EXP(.001A55*(122.-TB(MA)/TDE))
     WRITE(6,32029) TH(MA),AMI(L),AME(L),TEPRL
```

```
IF(N.LE.1) GO TO 2425
```

```
WRITE(6,2003) (I,AP(MA,I),DE(I),RO(I),EPR(I),R(I),
*  I=1,N)
```

```
2425 HPTOT(L,MA)=TEPRL
     L=L+1
```

```
IF(LX.GE.L) GO TO 2100

NA=NA+1

IF(NA.GE.AA) GO TO 2250

2450  CONTINUE
3200B FORMAT(1H1)

RETURN

END
```

```
(ENTRANCE)

*MAIN
     [illegible] MAIN
     REAL NET
* COM
     [illegible] ATOT(7,10),HRITT(7,10)-NA
     [illegible] USNS(5),SMN(5),NET(5),M1,M2,RANGE(5)
     [illegible] (5,10)
     [illegible]
     [illegible] SPEC,AM1(7),AME(7)
     [illegible] SN(5,5)
     [illegible] NFIRST/1/
     IR=IR+1

     GO TO (10,20), NFIRST

10   NFIRST=2

     DO 30 M=1,IW

30   [illegible] (RANGE(M)) 250.)

20   CONTINUE

     DO 200 L=1,NSPEC
```

```
      IF(L.EQ.N1.OR.L.EQ.N2) GO TO 200

      J=LA(L)

      DO 100 M=1,IR

      DST=RANGE(M)+250.
   80 SN(J,M)=ALOG(ATOT(L,M)*DSMS(J)/DST**2/NEI(J))-6.8341
            LN((CM/FT)**2)=6.3341

  100 CONTINUE
      IOC=-2
      SG=ALOG(SMN(J))

      IF(IR.EQ.2) GO TO 150

      IOC=-1
      NST=1

      IF(IR.EQ.3) GO TO 140
```

```
  120 IF(SN.LT.SN(J,NST+2)) GO TO 140

      NST=NST+1

      IF((NST+2).LT.IR) GO TO 120

  140 B=(D(NST)-D(NST+1))/(SN(J,NST)-SN(J,NST+1))
      A=(B-(D(NST+1)-D(NST+2))/(SN(J,NST+1)-SN(J,NST+2)))/
     * (SN(J,NST)-SN(J,NST+2))
      B=B-A*(SN(J,NST)+SN(J,NST+1))
      C=D(NST)-(A*SN(J,NST)+B)*SN(J,NST)
  155 DMA=EXP((A*SQ+B)*SQ+C)

      GO TO 190

  150 A=(SQ-SN(J,1))/(SN(J,1)-SN(J,2))
      DMA=EXP(D(1)+A*(D(1)-D(2)))

  190 CONTINUE
      DM(J,NA)=DMA

  200 CONTINUE
```

RETURN

END

(ENTRANCE)

```
**PLUMEX
      SUBROUTINE PLUMEX
      COMMON/PLUME/FRQ,IA,AX1,TR(7),FIRST,PC1,PC2,NTR,ZA,SS
     * ,HT(7),SPEC,IF
      COMMON/PREP/ADG,IS,PCIR1,PCIR2,CIR1,CIR2,PRQAMB,END
      COMMON/INTERF/IZ,IS,AR,PR,PAND,TAMB,V19,XM,ALTJ,FARS
      COMMON/TW/TW(5),ASP(10),EMS(5)
      COMMON/COM/NSPEC,AMI(7),AME(7)
      COMMON/ASYS/ASYS(5),SN(5),MEI(5),N1,N2,RANGE(5)
     * ,FLA,DMY(5,10)
      COMMON/ENV/NDA,TA(5),DA(5),XMA(5),PA(5),THT,RH,ALT
      COMMON/TAL/AT(7,10),HPIDT(7,10)
      COMMON/CNT,T(7),XS(7),XH(7),XC(7),PX(7),VR,ATMS,NPRINT
      COMMON/MICHC/SKIP,AA(1000)
      COMMON/RAY/NDT,WV(300)
      COMMON/RANGE/MX,BB(1000)
      DIMENSION A1(7),P2(7)
      DATA COP/57.2957/

      IF(IA.NE.1.OR.IW.NE.1) GO TO 130

C     SEQUENCE WAVELENGTH BANDS

      DO 30 I=2,NSPEC

      DO 20 J=2,I

      IM=I-K2
```

```
      IF(AMI(L).GE.AMI(L-1)) GO TO 90

      LT=LA(L)
      LA(L)=LA(L-1)
      LA(L-1)=LT
      XT=AMI(L)
      AMI(L)=AMI(L-1)
      AMI(L-1)=XT
      XT=AME(L)
      AME(L)=AME(L-1)
      AME(L-1)=XT

   90 CONTINUE
      CALL WAVE
C       PREPARE ATMOSPHERIC TABLE
      XRC=TA-7.0A7A25
      XHA=.11052*XRC
      XHI=.15079*XRC
      CALL PLVT
      WRITE(6,9009) (TA(I),PA(I),XHA(I),DA(I),I=1,NDA)
 9009 FORMAT(//10X,17HATMOSPHERIC TABLE//
     * 5X,4HTEMP,6X,5HPRESS,5X,3HH2O,7X,4HDIST/
     *5X,7H(DEG R),3X,6H(PSIA),4X,4HCONC,6X,6H(FEET)//
     * 1X(F12.4/))

  130 CONTINUE
C       COMPUTE RAY PROPERTIES

      IF(AXI.EQ.1.) GO TO 10

      DXA=SQRT(AB*AXI/4.)
      DXB=2.*DXX*(AXI-1.)
      ATST=ATAN(DXX/DXA)*COR
      IF(THI.GT.ATST) DXA=DXX/SIN(THI/COR)
```

```
      GO TO 20

   10 DX=S.*(TAB/3.1415*A90)/12.
      DX=DX

   20 CONTINUE
      IF(DA(DA).LT.RANGE(IR))DA(DA)=RANGE(IR)+1.
      IR=IRA+1
      J=0

   140 IF(RANGE(IR).GT.DA(1)) GO TO 150

      I=I-1

      IF(  ) 2,3,1

   150 X=  RANGE(IR)-DA
      T( )=  ( )
      ( )=  ( )
      X(1, , )
      A(  )
      J=1
```

```
161 IF(I.EQ.1) GO TO 170
```

```
J=J+1
I=J-1
PA(J)=.5*(PA(I)+PA(I+1))
T(J)=.5*(TA(I)+TA(I+1))
XH(J)=.5*(XHA(I)+XHA(I+1))
XS(J)=DA(I+1)-DA(I)
XC(J)=.00033
```

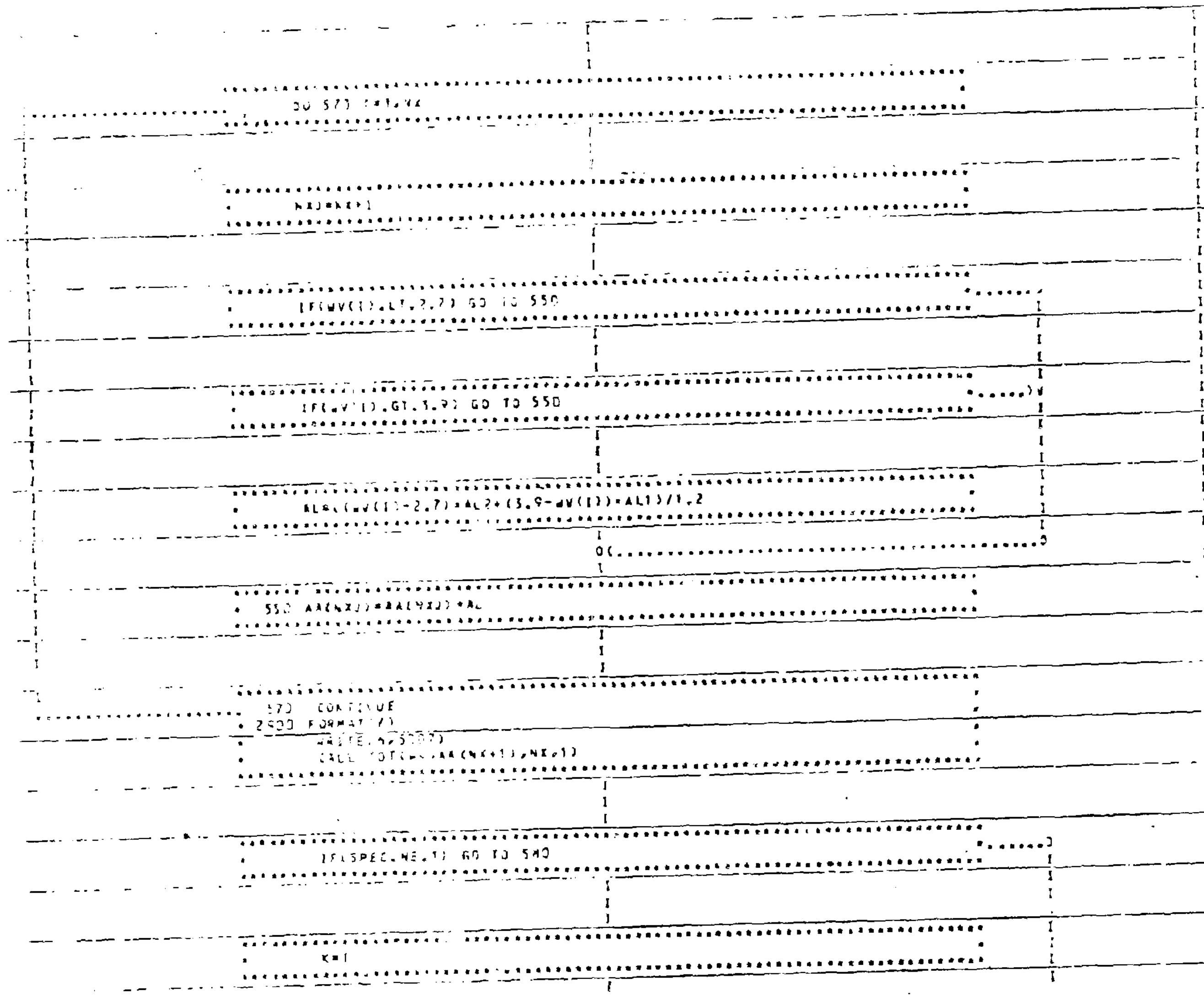
```
GO TO 160
```

```
170 ATMS=1
NCNT=J+1
XS(NCNT)=DXX/55
PA(NCNT)=PAMB/14.697
T(NCNT)=.5*(TS+TA10)
XC(NCNT)=.5*XRC+.00033
XH(NCNT)=.5*XRH+XHA(NCNT-1)
NCNT=NCNT+1
XS(NCNT)=DXA*SA
PA(NCNT)=PAMB/14.697
XC(NCNT)=XRC+.00033
XH(NCNT)=XRH+XHA(NCNT-2)
T(NCNT)=TS
C CALCULATE PLUME EMISSION/TRANSMISSION
CALL GEMS
NIX=NIX+1
C DETERMINE BAND TRANSMISSIVITIES
WRITE(6,2800)
2800 FORMAT(//3X,57HAVERAGE PLUME/ATMOSPHERE TRANSMISSIVITY//)
CALL TOT(WV,AA,NIX-1,2)
```

```
DO 500 I=1,NSPEC
```

```
      N=NTEST
      IN(I)=AA(NN)

  500 CONTINUE

      IF(NTR.EQ.1) GO TO 530

C     LOCATE REFERENCE BANDS
      CALL TOT(-7,AA(JX+1),NX,0)

      IF(FIRST.NE.0..OR.IT.NE.0) GO TO 520

      DO 510 I=1,NSPEC

      IF(SHI(I).GT.1.6) GO TO 505

      IF(SHE(I).NE.2.7) GO TO 505

      NT=I
      IF(N.NE.0) NT=I
```

```
      GO TO 510

  505 IF(AME(I).NE.3.9) GO TO 510

      IF(AME(I).EQ.4.8) GO TO 515

  510 CONTINUE

  515 N22=I+1
      N22=I
      IF(N2.NE.0) N2=1
C        DETERMINE NORMALIZING COEFFICIENTS

  520 IA=IXX+A11
      A1(IA)=PC1/AA(VI)
      N1=NXX+N22
      A2(IA)=PC2/AA(VI)

  530 AL1=A1(IA)
      AL2=A2(IA)
C        NORMALIZE RADIANCE
      I=1
      AL=AL1
```



DO 570 I=1,NX
NXJ=NXJ+1
IF(WV(I).LT.2.7) GO TO 550
IF(WV(I).GT.3.9) GO TO 550
AL=((WV(I)-2.7)*AL2+(3.9-WV(I))*AL1)/1.2
550 AA(NXJ)=AA(NXJ)+AL
570 CONTINUE
2500 FORMAT(/)
WRITE(6,2500)
IF(SPEC.NE.1) GO TO 5?0
K=1

```
      GO TO 565
  575 WRITE(6,2950)
      DO 560 I=NX1,NX2
      J=NX+I
      K=I+NTT
      IF(K.GT.NX) K=NX
      L=NX+K
      NC=NC+1
      IF(NC.NE.5)GO TO 560
      NC=0
      WRITE(6,2900)
      NST=NST+1
      IF(NST.EQ.8) GO TO 565
  560 WRITE(6,3000)W(I),AA(J),AA(I),WW(K),AA(L),AA(K)
```

```
 515  NC1=1
      NX1=0
      NC=-1
      NX2=...+(N+1)/2+NX1
      NI1=NX2-NX1+1
      IF(NI1.GT.40) NI1=40
```

```
      IF(NX1-NX2)575,580,580
```

```
 8003 FORMAT(3F15.4,5X,3F15.4)
 2550 FORMAT(1H1/2(7X,10HWAVELENGTH,4X,
     * 10HIRRADIANCE,2X,12HTRANSMISSIVITY,3X)/
     * 2(5X,9H(MICRONS),5X,15H(WATTS/STER/MICRON),9X)//)
 8057 FORMAT(//3X,15HPLUME IR TOTALS/)
```

```
 580  CONTINUE
```

```
      DO 5 0 I=1,NSPEC
```

```
      NX1=NX1+1
```

```
 600  HI(I)=A (NX1)
```

```
                                   I                                                          I
                                   O(.........................................................O
                                   I
  ***************************************************************************
  *  930  RETURN                                                            *
  ***************************************************************************

  ***************************************************************************
  *      END                                                                *
  ***************************************************************************
```

```
(ENTRANCE)

ENVT
      SUBROUTINE ENVT
C
C     SUBROUTINE TO COMPUTE ENVIRONMENTAL CONDITIONS
C
      COMMON/ENVI/NDATA,TA(5),DA(5),HA(5),PA(5),THT,RH,ALT
      DIMENSION PL(15),AL(5),AT(5)
      DATA PL/.00011,.000237,.000421,.000735,.00126,.00210,.00344,
     1 .00551,.00829,.01213,.01745,.0247,.03449,.04753,.0645/
      DATA SS/1./,AB/1./
      DATA AL/0.,0.,11.,25.,48.,80./
      DATA AT/0.,-72.,0.,72.,0./

      DT=0.
      NX=2

      IF(ALT.EQ.0.) GO TO 40

      IF(ALT.GT.11.) GO TO 10

      DT=-72.*ALT/11.

      GO TO 40

   10 IF(ALT.GT.25.) GO TO 20

      DT=-72.
      NX=3
```

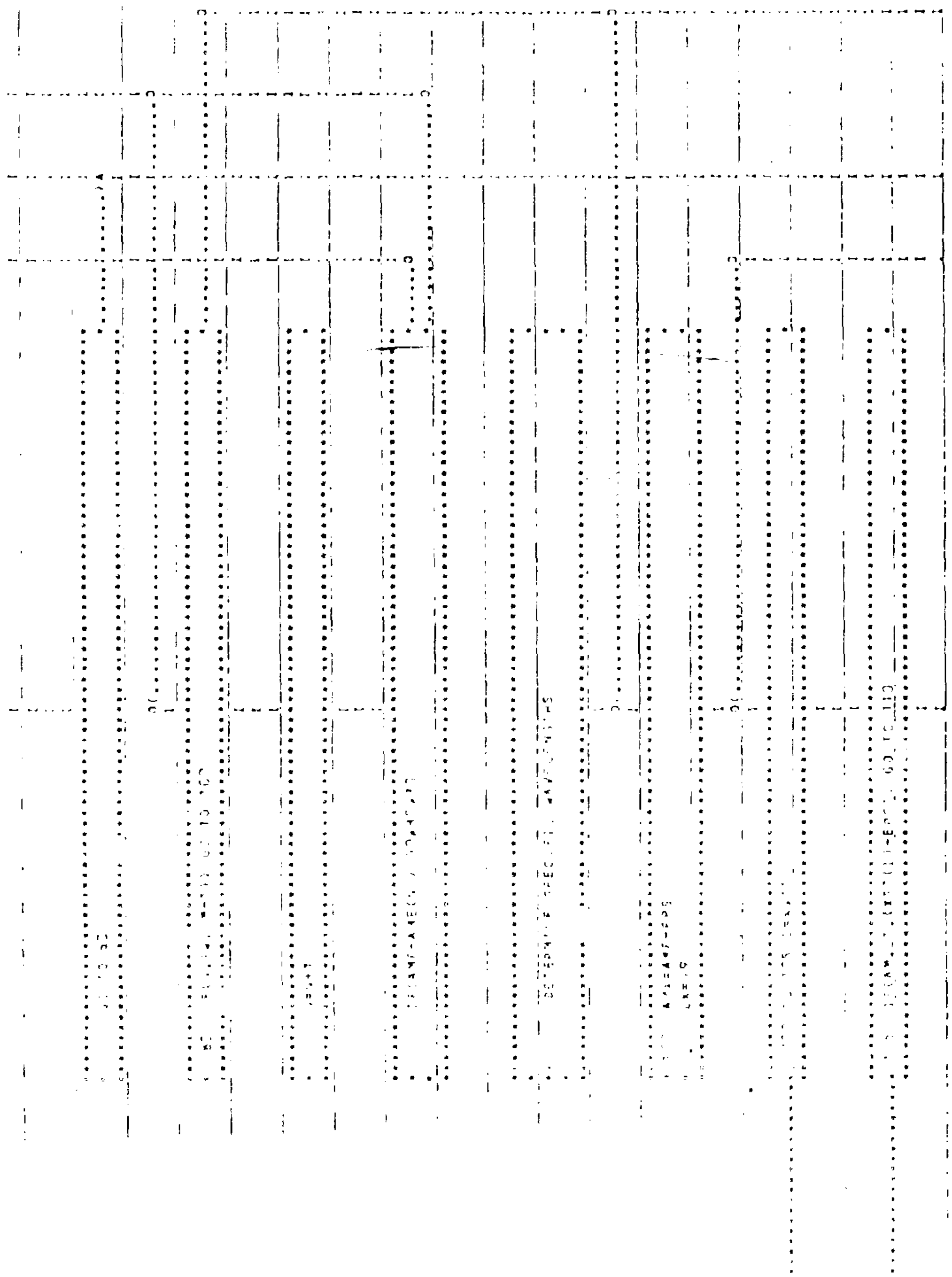
```
      GO TO 20

20    WX=5

      IF(ALT.GT.48.) GO TO 43

      WX=4
      DTX=72.*(1.-(ALT-25.)/23.)

45    TH=STR,PDT

      TL=TA(1)

      GDA=1
      H=ALT

      IF(THT.EQ.0.) GO TO 200

      SS=-3.4(.DTX+STC*THT.

      IF(THT.LT.0.) GO TO 45
```

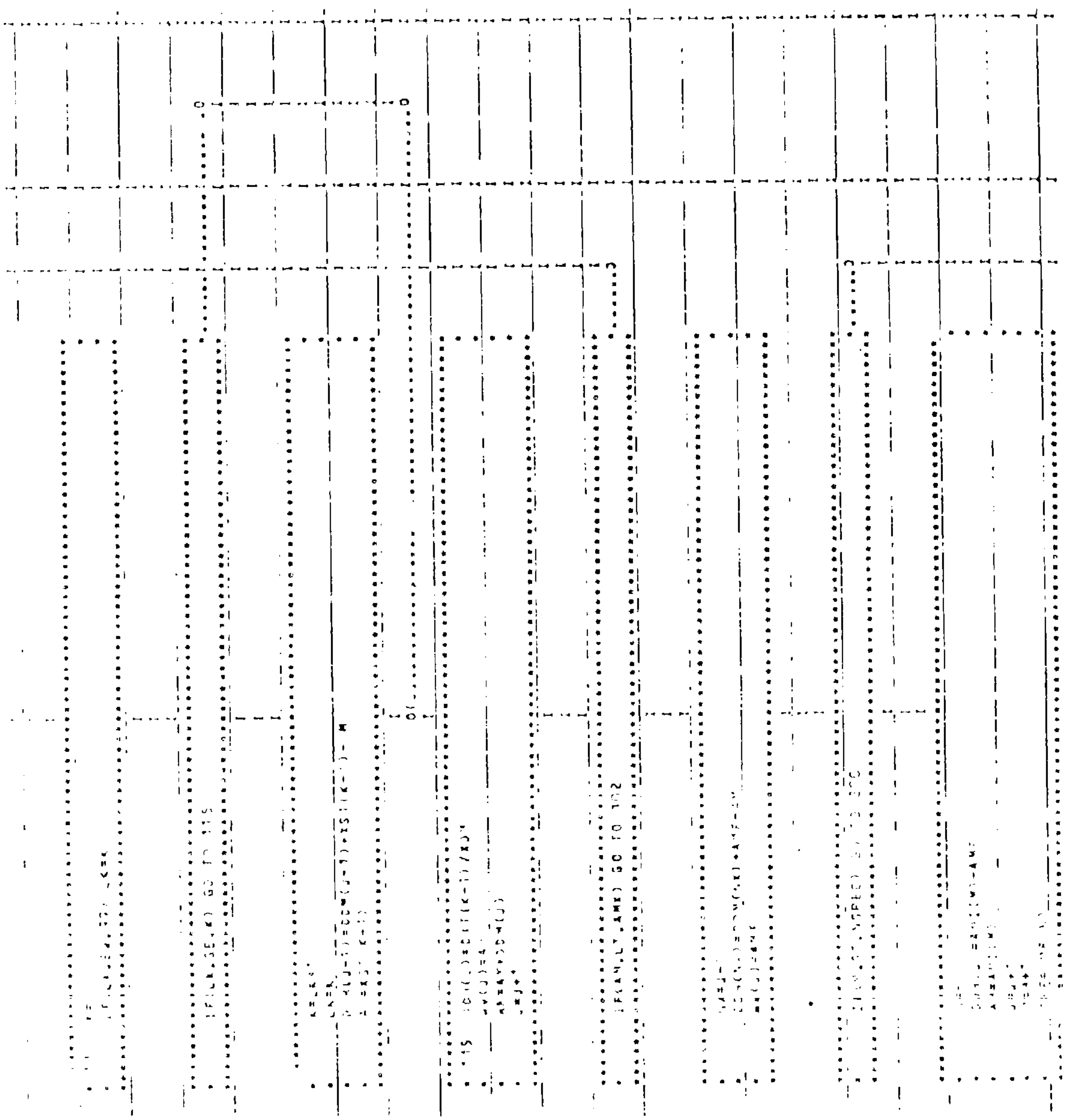
```
      AN=-1.
      NG=G-NX
      F=(AL(NX+1)-H)/(AL(NX+1)-AL(NX))
      NX=NX+1

      GO TO 50

   40

   45 NG=NX-1
      F=(H-AL(NX))/(AL(NX+1)-AL(NX))

   50

   50 NG=AG

      DO 100 J=1,NA

      NC=IAL+F+1.
      AN=NC
      C=F-AN*L(NG)/ANC
      D=F*AF(NA)/ANC*A.

      DO 150 K=1,NC
```

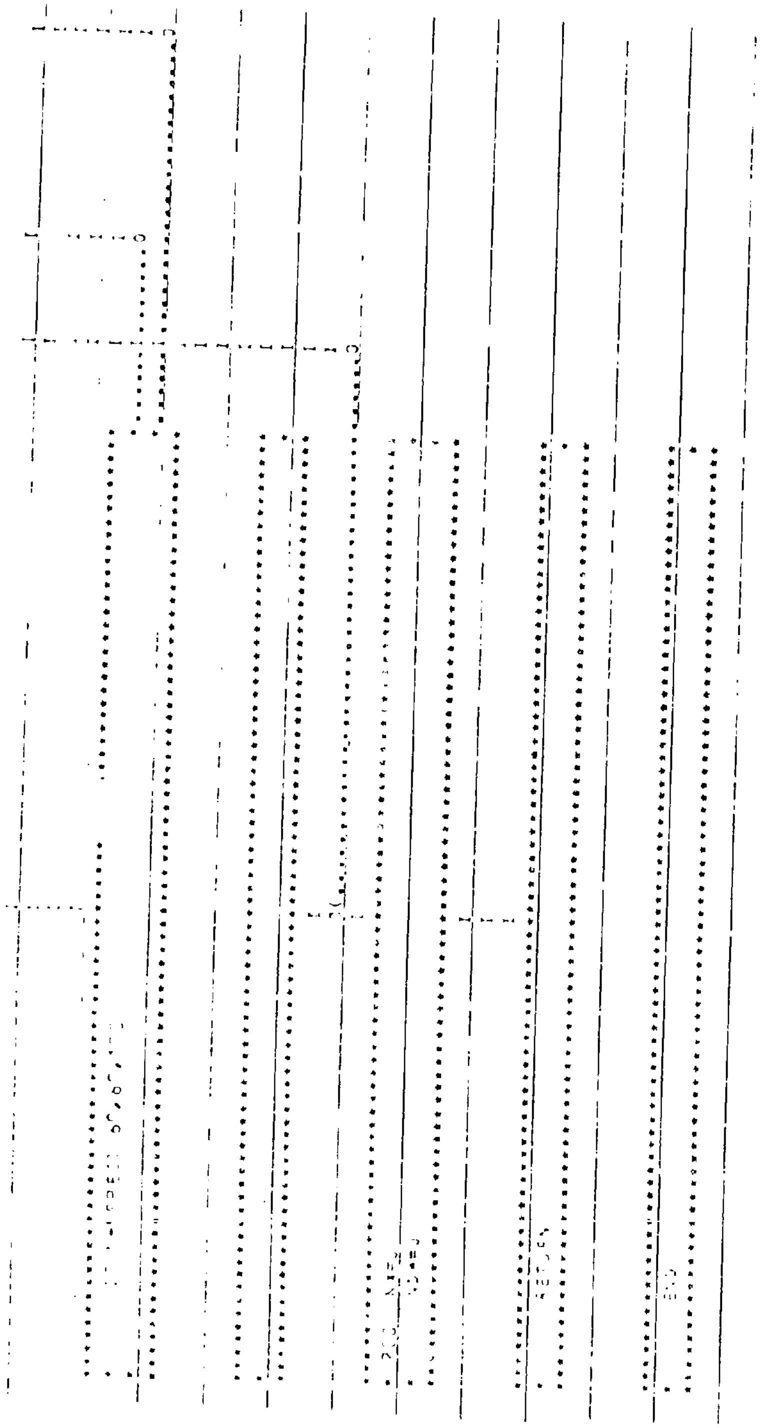
```
      PA(ND)=EXP(-.03537*H)
      TA(ND)=TL
      [illegible]
      DA(NDA)=(ALT-H)*1000./SS
      H=H-DH

      IF(H.LE.0.) GO TO 200

  150 NDA=NDA+1
      F=1.

  [illegible] H=[illegible]-12
      NDA=NDA-1

      GO TO 250

  200 TA(NDA)=TL
      PA(NDA)=EXP(-.03537*H)
      DA(NDA)=(ALT-H)*1000./SS

      IF(T-T.NE.0.) GO TO 250
```

```
      IF(NDA.EQ.2) GO TO 240
      NDA=NDA+1
      TA(NDA)=TL
      PA(NDA)=PA(NDA-1)

  240 PA(NDA)=100000.

  250 CONTINUE
      [illegible]
      [illegible]
      IF(BL.LT.10.) BL=10.
      [illegible]
      [illegible]
      [illegible]
      [illegible] PL(NL)+BL*(PL(NL+1)-PL(NL)) )
      [illegible] (P,+PA(I)))

      [illegible] =2,NDA

      [illegible] (-P(I)/PA(I))

      [illegible]
```

```
ENTRANCE)
    I
**WAVE
     SUBROUTINE WAVE
     COMMON/COHANSPEC/AM(17),AMF(7)
   RANGE
     COMMON/RANGE/NX,ADM(  )
SET
     COMMON/RAN/NDM,W(300)
     DIMENSION XST(11),DXT(11)
     DATA XST/ ,.1.05,1.55,1.7,2.1,2.3,3.5,4.1,4.2,4.6,9./
     DATA KOM/ /
     EQUIV
     DATA DXT/.05,.03,.05,.12,.05,.02,.1,.01,.025,.1,.2/
     DATA EPS/.00001/

  3.   ARRAY(1),
     K=1
     M=2
     L=1
     N=2
     NBAND

** DETERMINE CONTINUOUS RANGES
    I
    )(...................................................0
    I
  3.   AMF=AM(N)
    I
    )(..........................................I.........0
    I
     IF AMF.LT.AM(N)) GO TO 87                  I         I.........0
    I
     L=1
    I
     IF(AM(M).EQ.BITS) GO TO 80                 I         I         IV
    I
```







```
(ENTHANCE)

**HS
      SUBROUTINE CEMS
**  INP
      COMMON/RAY/NDM,RY(300)
      COMMON/COM/NSPEC,AMI(7),AME(7)
      COMMON/PARAM/VENT,T(7),XS(7),XM(7),AC(7),PX(7),VR,ATMS,NPRINT
      COMMON /HIDRON/SHIP,AA(1000)
      COMMON/RANGE/NX,BE
      EQUIVALENCE (
      EQUIVALENCE (Z(1),
      COMMON/ADD/HCX(300)
**  RANGE
      DIMENSION DTM(1)
      DIMENSION Z(1),AI(1)
      KS=0,
      S
      VR=1.,
      NPRINT=3
      IF(ATMS,GT,0.) NPRINT=6
      NA1=NX

      DO 15 J=1,NX

      AA(J)=1,
      HSX(J)=0,
      HSQ(J)=0,
      N=J+NX
      AA(N)=0,
      RH(N)=0,
      N=N+NX
      RG(N)=0,

   15 AA(N)=0,
      SKT=0.0
```

```
      DO 35 I=1,NCNT

      P=PI(I)
      TC=2.5898E4/T(I)
      AM=AMI(I)

      DO 30 J=1,NX

 25   G=TC/AM

      IF(NPRINT.GT.3) GO TO 1400

      IF(G.GT.80.)G=80.
      RI=11905./AM**3/(EXP(G)-1.)
      JA=J+NAI
      AI(JA)=AI(JA)+RI*Z(J)

 1400 CALL EMIST(AM,T(I),XC(I),XM(I),X3,XS(I),P,SN,ZJ)
      IF(ZJ.LT.Z(J)) Z(J)=ZJ

      IF(NPRINT.GT.3) GO TO 30
```

```
AI(JA)=AI(JA)-PI*Z(J)

30    AM=AM+DDM(J)
      ATMS=ATMS-1.

35    IF(ATMS.LE.0.) NPRINT=3

      RETURN

      END
```

```
(ENTRANCE)
    I
    I
**EMIS [illegible]
*       [illegible] X3,YS,P,[illegible],TAK)
**COM
*       [illegible]
*       [illegible],ANE(7)
*       [illegible]
** RAN [illegible]
*       [illegible]
*       DIMENSION [illegible],ANC(3)
*       DIMENSION [illegible],PS(14),R(3),F(3,5),
*      [illegible],NC2(14),NC3(14)
*       DIMENSION [illegible],ANU(3),CF(3,5),CG(3,3)
*       DIMENSION [illegible],HPH(9)
*       DIMENSION [illegible]
*       [illegible],IR,ATMS,NPRINT
*       [illegible]
*
*C      [illegible]
*
*       DATA [illegible],7,.1575,[illegible]/
*       DATA [illegible],.5135,.3755,.3650,.3151,.1575,.1.0/
*       DATA [illegible].28,1.263,4.27.05,2.23,484.5,167.5/
*       DATA [illegible]24,1.0559,1.2037,1.0545,1.0185,1.0989,
*      [illegible]/
*       DATA [illegible]/
*       DATA [illegible]/
*       DATA [illegible]/
*
*C      [illegible]
*
*       DATA [illegible]/
*       DATA [illegible].1545,.
*      [illegible],.742,.721,.657,/
*       DATA [illegible],.553,.0,.0,.
*      [illegible]/
*       DATA [illegible],2.42,8.28,5,2706,.,02,
*      [illegible],.240,/
*       DATA [illegible],1.2537,1.5475,1.1117,
*      [illegible],1.0145,1.0078,1.0717,1.0016/
*       DATA [illegible]/
*       DATA [illegible]/
*       DATA [illegible]/
*C
*C      [illegible]
*C
*       DATA [illegible],.1285,.2245,.2331,/
*       DATA [illegible],.00315,.0135,0.08/
*       DATA [illegible]/
*       DATA [illegible]/
*       DATA [illegible]/
*
*       DATA [illegible]/
```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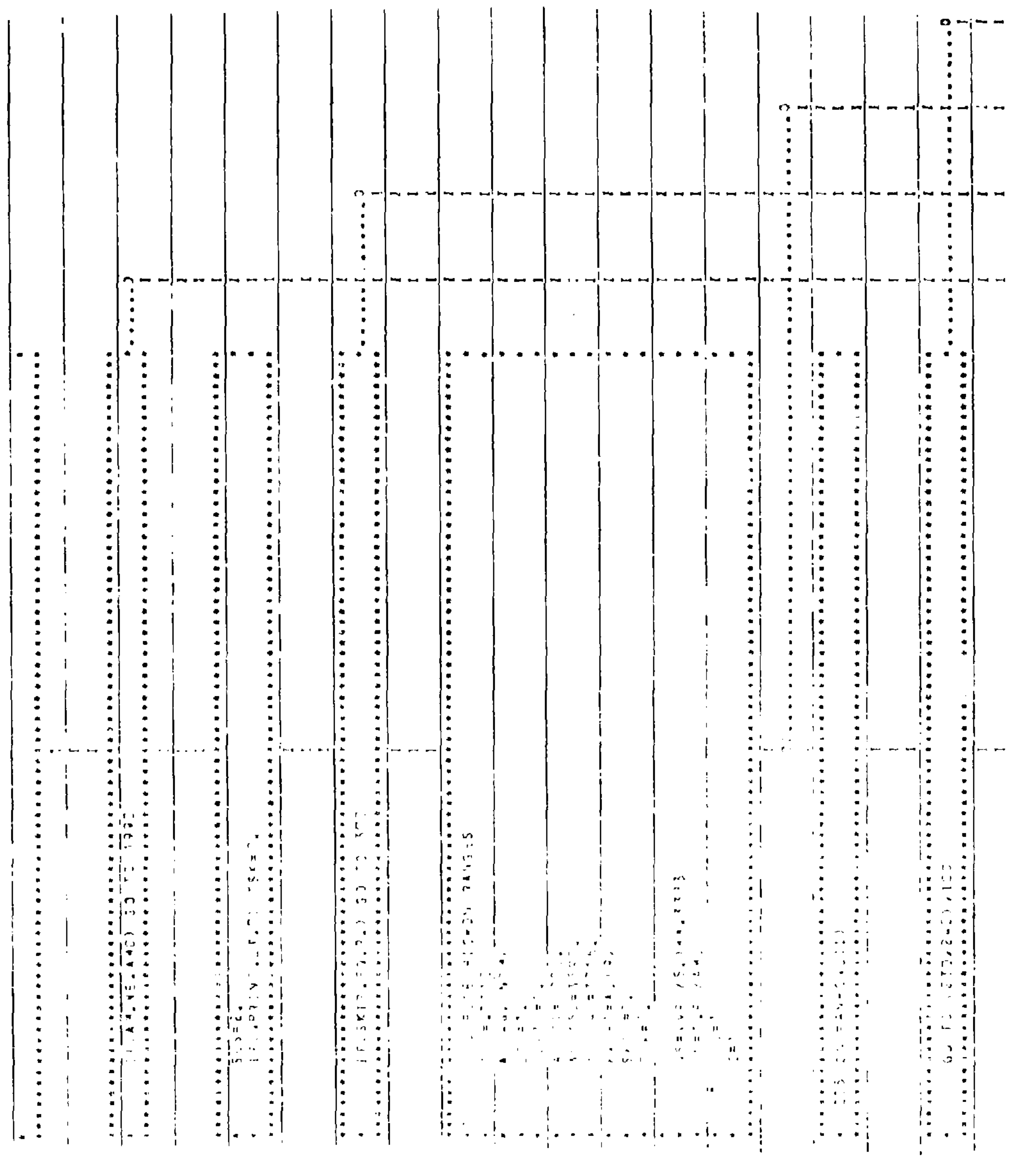
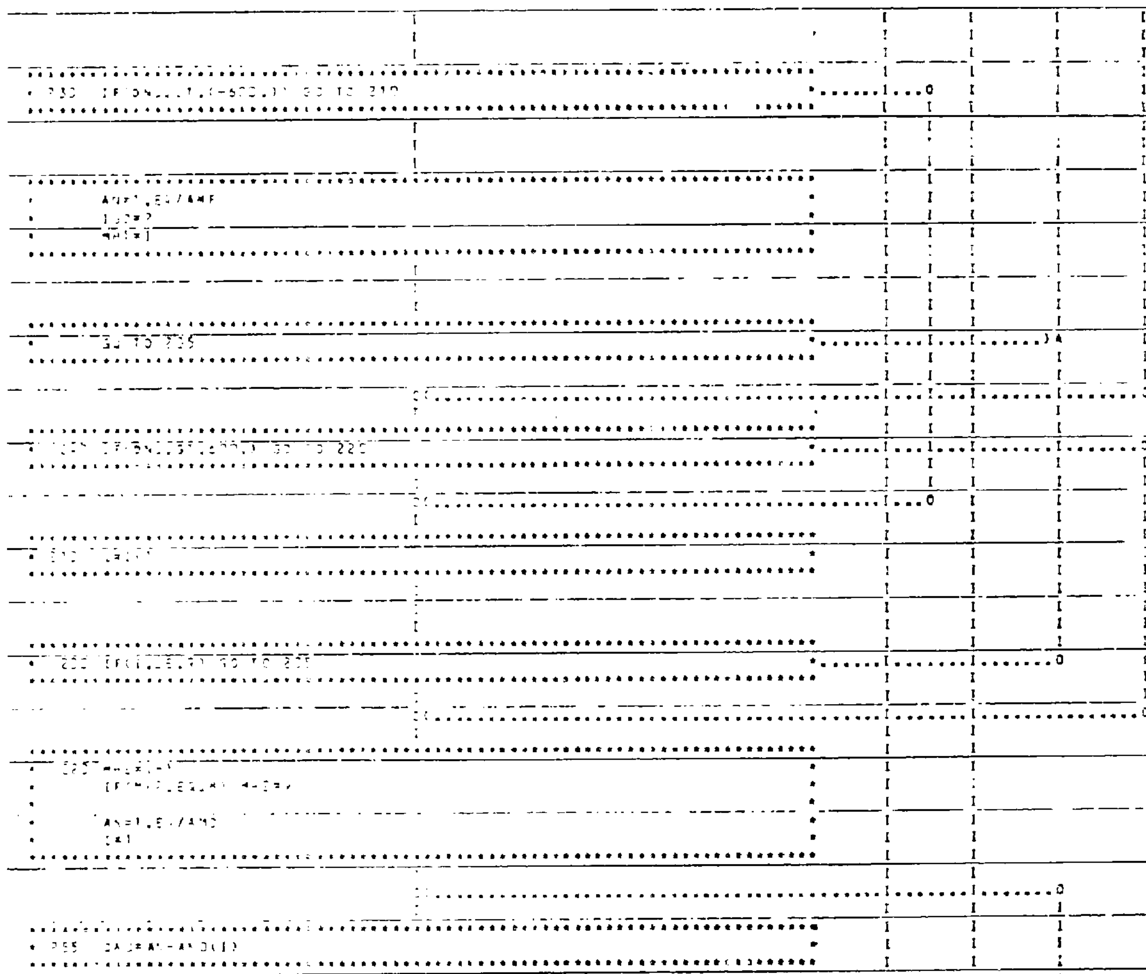
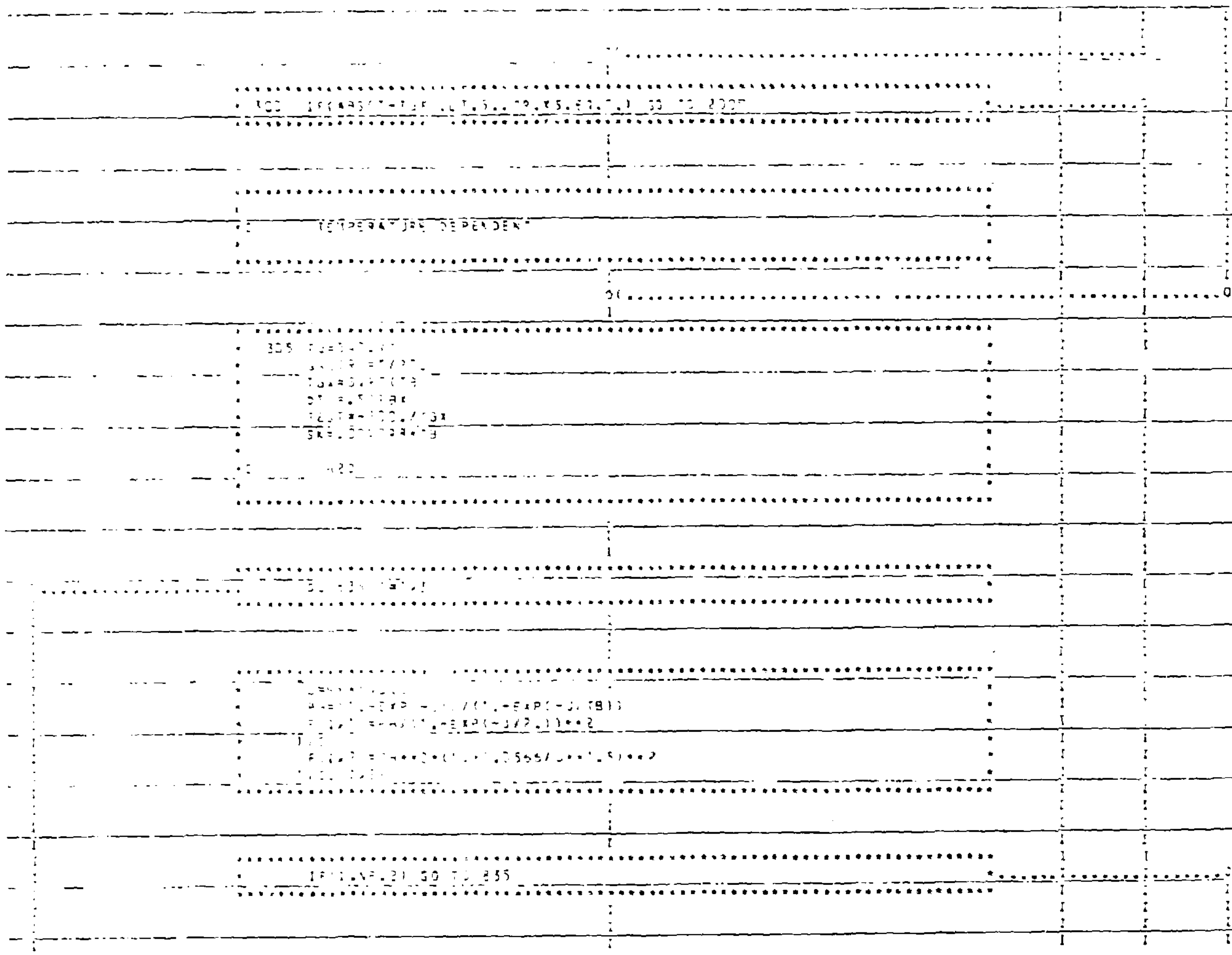
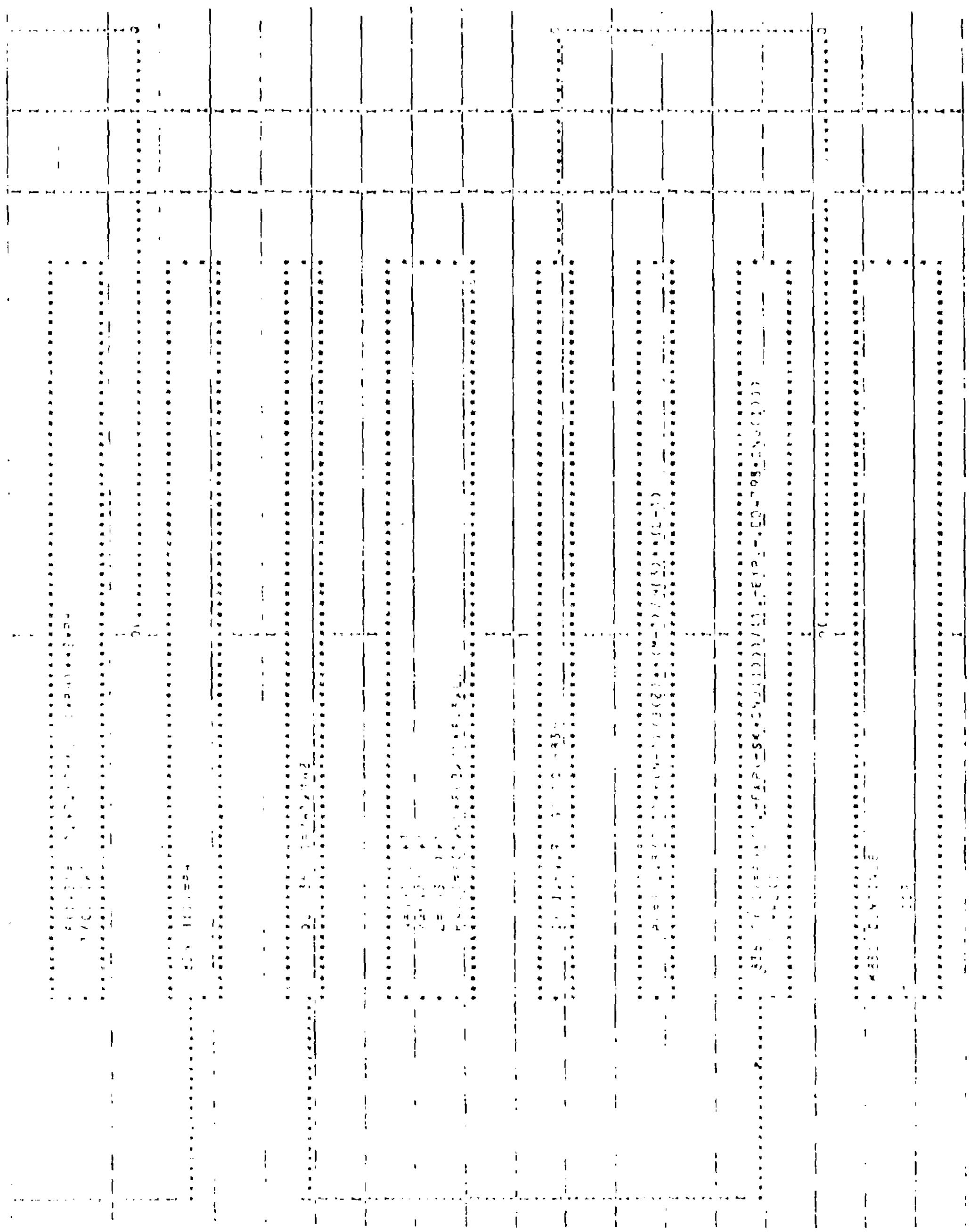


Copy available to DDC does not
permit fully legible reproduction


GO TO 235
AN=1.E4/AMD


TEMPERATURE DEPENDENT



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permit fully legible reproduction

```
D. 837 ... X*3
```

```
...EXP(-U/T))
...EXP(-U/T...))**2
...
...**2 ...+2.25657/U+...57**2
...
```

```
IF (...E...3) GO TO 837
```

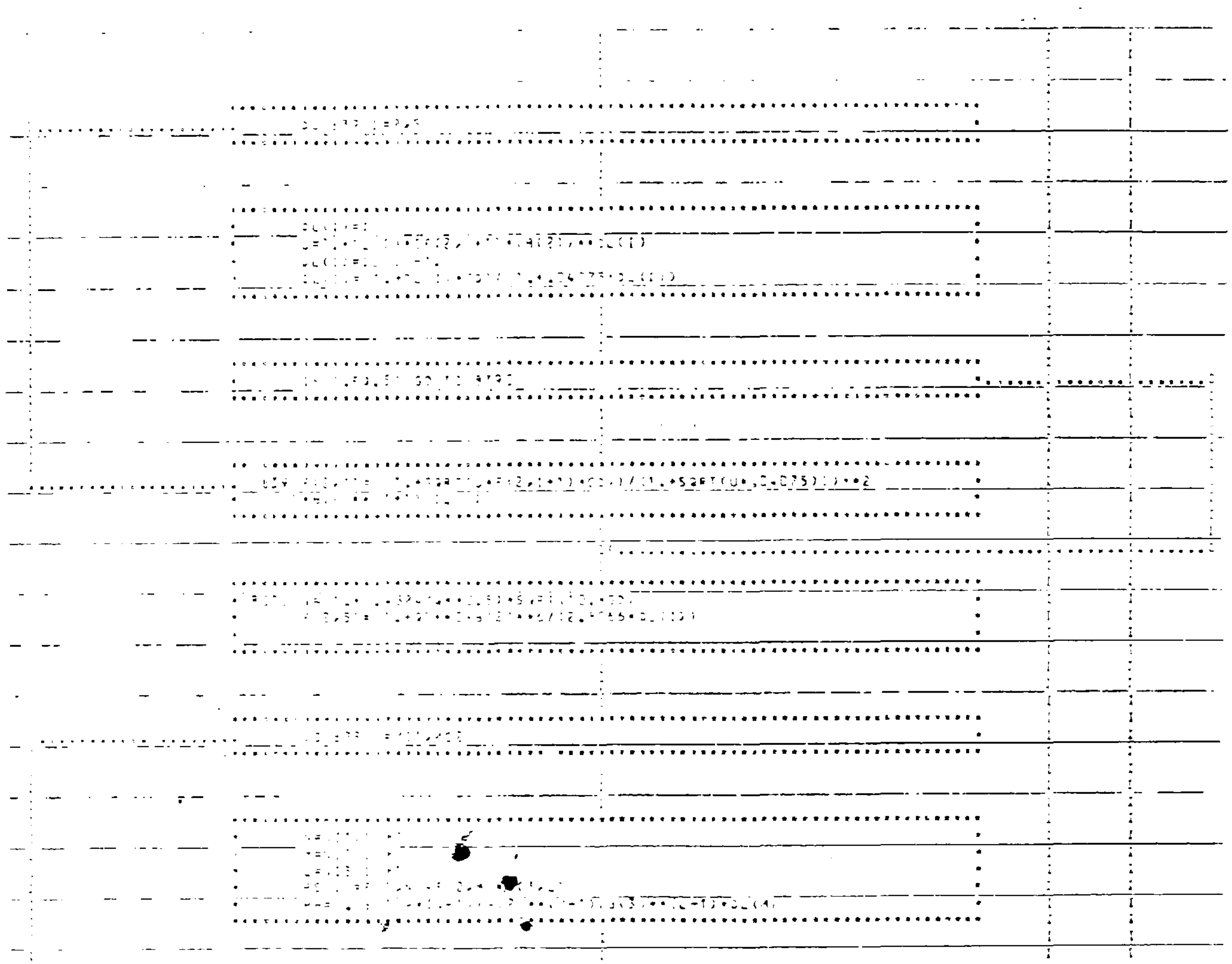
```
...+2.3283/U/...PH)**2*PH
...
```

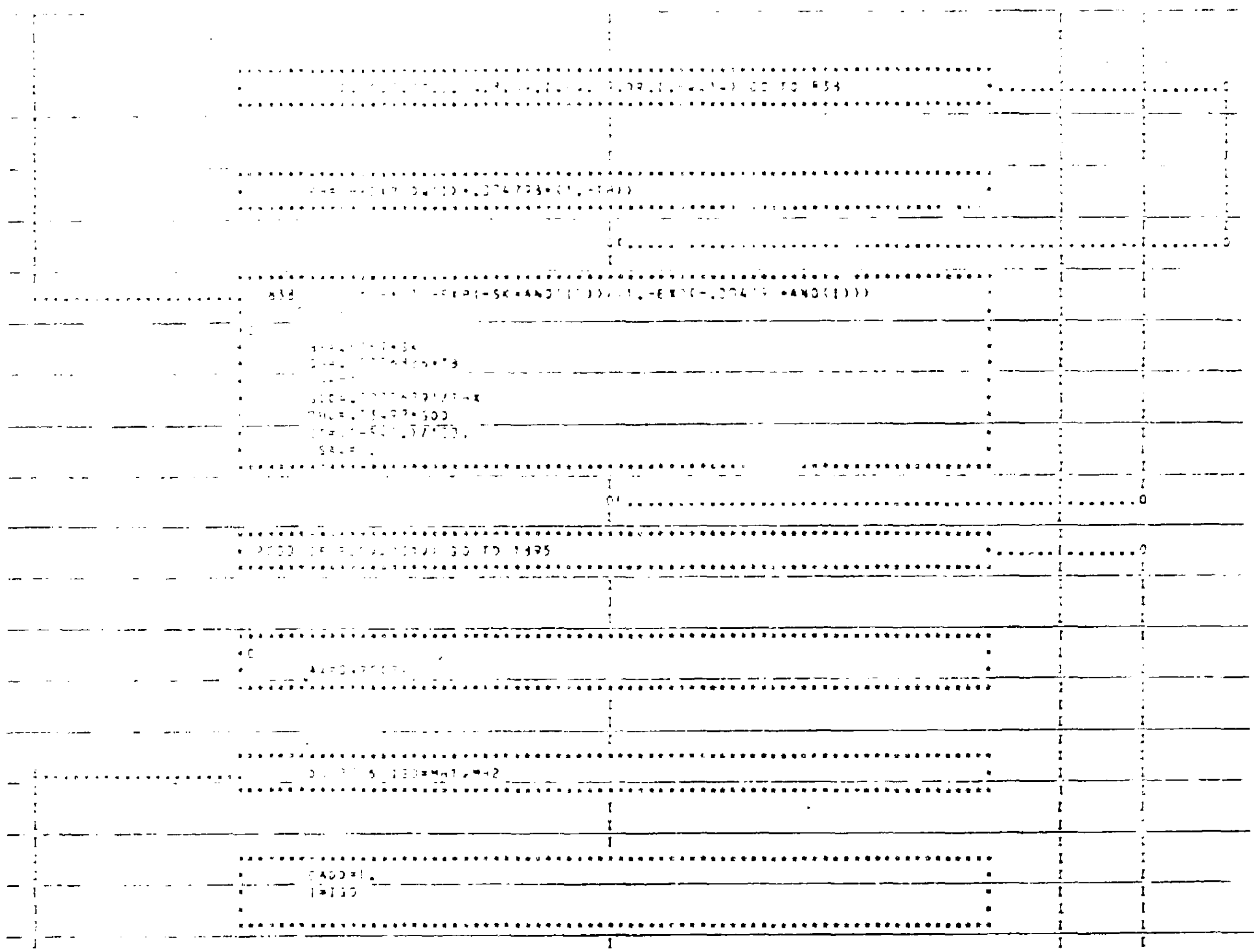
```
IF (...E...) GO TO 837
```

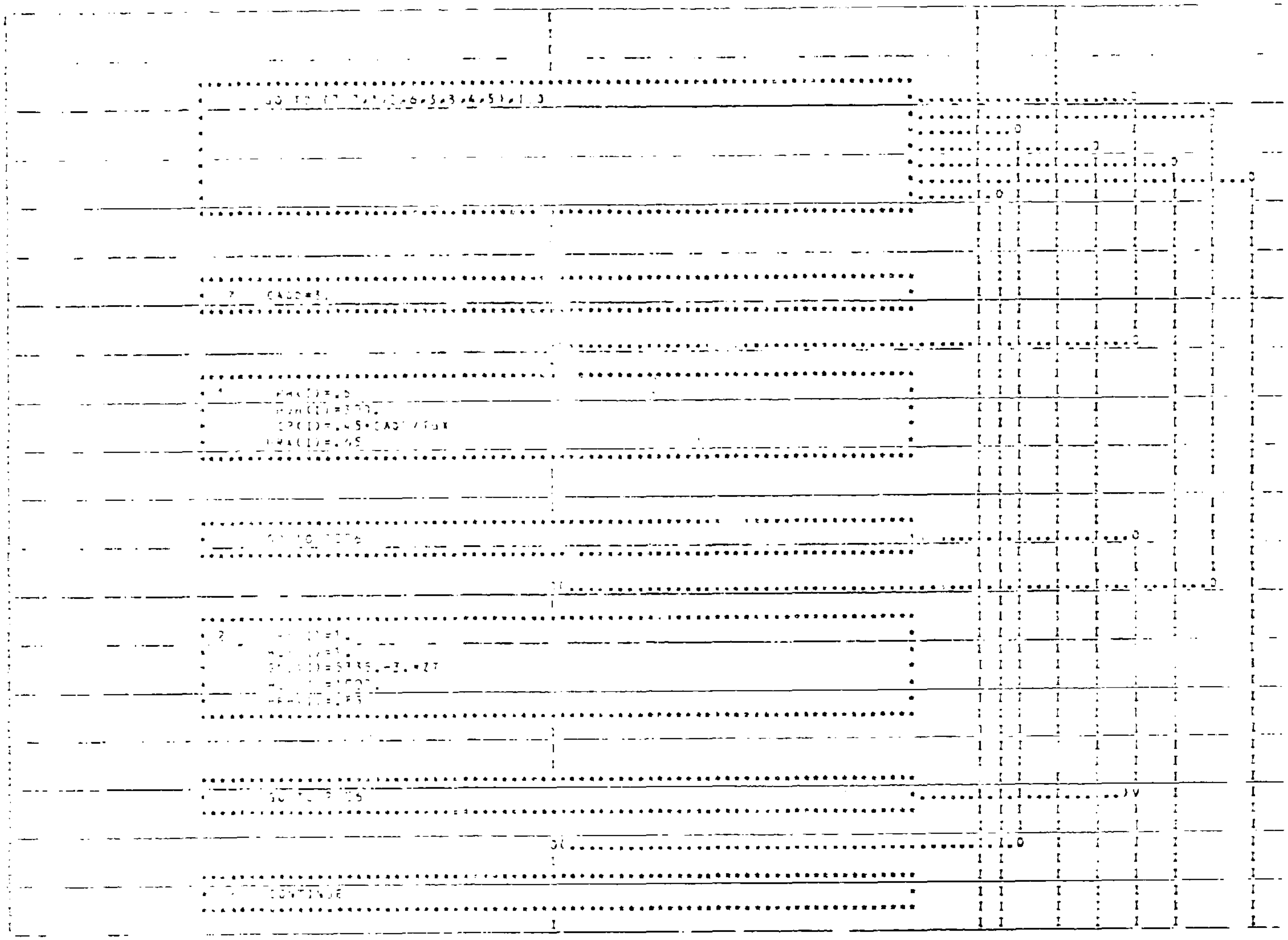
```
...+5.2355/U**2.5)**2*PH**4.
...
...1.555/U**7.0)**3*PH**5.
...
...=EXP...
...
```

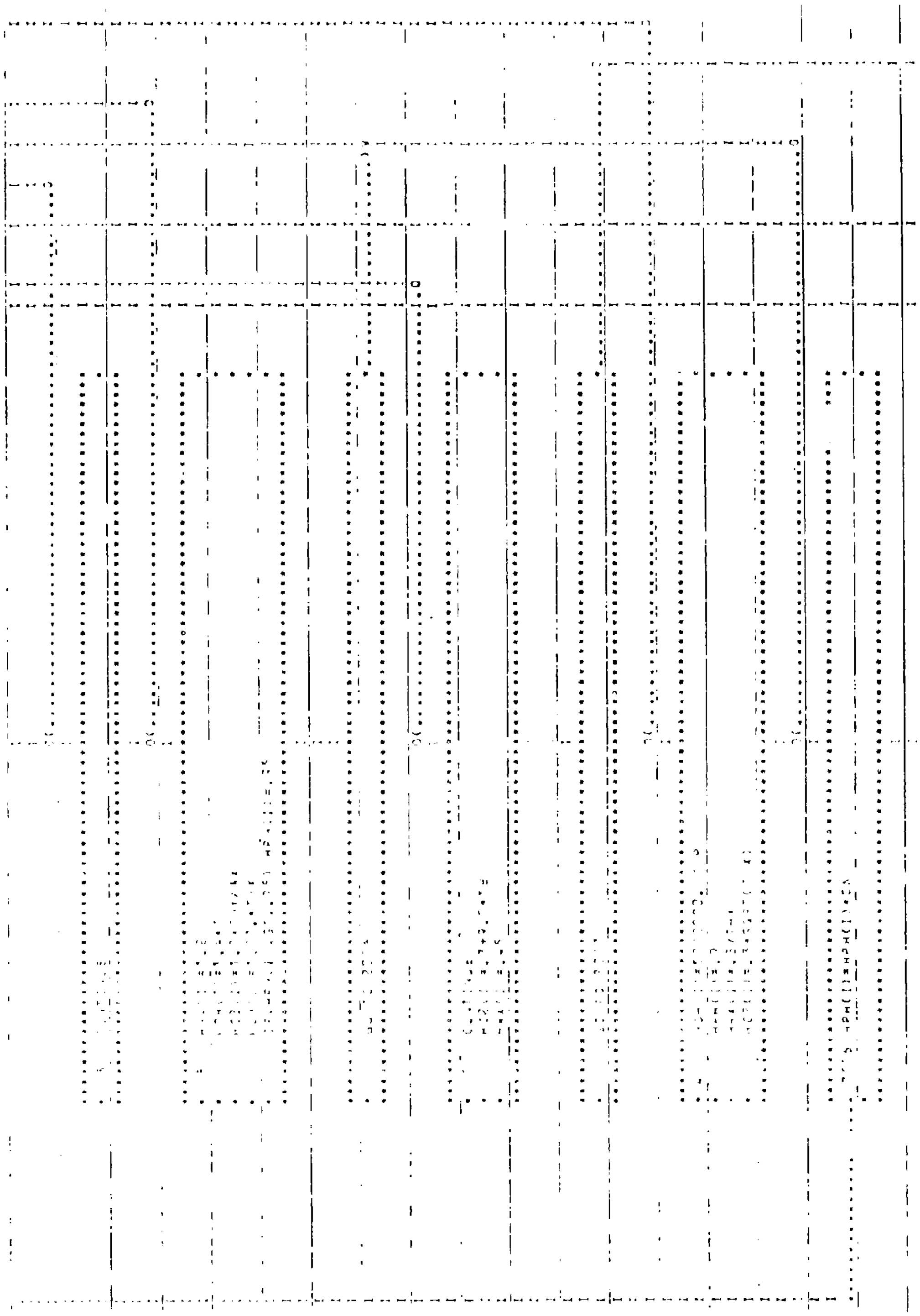
```
837 ...
```

```
CORRECTION FOR DEGENERACY
```






CONTINUE



```
 2107 CONTINUE
      DH=S1.7P**.6
      C2=AC/5.25/T@I
      RK

      IF(P.GT.1.05) GO TO 1894

      C2=C2*(.C221/P+.5).529*P)

 1894 CONTINUE
      PS1V*P

 1895 S1=1S*P
      K1=S1*T
      S1=S1*XC
      GD=F**P
      PH=GD* .29*(5.ATHX-.29)*RH)  *.042
      PI=PI+PI
      GJ=GD*0.75*(1.+.3*XC)
      RH=PH/PHD
      GLX*3D*PPI
      L=I
      J=J+K
      KK=.I

 1970 IAK=1.
      L=L+1
      J=J+1
      IF(SCS.EQ.1.) FSC(L)=(AM/.55)**2S
      KX=KX+I
      A=1.E4/AM
```

```
IF(I.EQ.2.) GO TO 2090

2     H2O

ATC=TH1/A1

DO 2035 I=NH1,NH2

DNU=XN-GNU(I)-ZT

IF(I.NE.2) GO TO 9

PPH=CY
BZI=0.
GB=1.

GO TO 2010
```

```
      7   CONTINUE

          IF(DNJ.GT.HDH(I)) GO TO 2090

          IF(DNJ.LT.TEST) GO TO 2785

          PPH=HPH(I)
          DNX=SQRT(1.-DNJ/HDH(I))
          DNJ=-DNJ
   2035   DNU=2.*HDH(I)*(1.-DNX)
          RU=1.001-DNU/HDH(I)/2.
          DNU=ABS(DNU)
          IF(DNX.LT.1.) RD=RD/DNX
          IF(DNU.LT.10.) DNU=10.

   2011   SDX=SS+DNU**2
         1    *HRY(I)
          SD =SS+DNU *              FX(I)*PPH/RD*XI*HC2(I)

          IF(I.GE.3) GO TO 2011

          AMX=SQRT(AM)
          SD=SD*AMX
          SDX=SDX*AMX
```

```
 2011  IF(SDX.GT.80.) GO TO 2012

       IF(SD .LT.1.) GO TO 2012

       SDX=SD/CA/EXP(SDX)
       HSG(L)=HSG(L)+SDX
       SXQ=SDX/PX(I)/P6
       HSX(L)=HSX(L)+SXQ

 2012  IF(DZ1.LT..2) GO TO 2055

       IF(DZ1.LT.10.) DZ1=10.
       DNU=   SQRT(HDH(I)*DZ1)
       DZ1=-DNU
       IF(I.EQ.5) DNU=DNU/5.
       IF(DNU.LT.5.) DNU=5.
       PPH=.6*HDH(I)/DNU*(CN-PPH)
       KU=1.

       GO TO 2010

 2023  CONTINUE
```

```
 2090  IF(S1.EQ.0.) GO TO 3090

C      CU2
       AX=-1.

       GO 1535(=HC1,HC2

 3005  AT=3045000.
       CADD=1.
       LGU=1
       DNU=AN-ANU(I)

       IF(DNJ.GT.DH) GO TO 3095

       IF(DNJ.LT.TEST) GO TO 1505

       DNK=SQRT(1.-RNJ/DH)
       IF(DNK.LT.BTT) CADD=(DNK/BTT)**(3.*P)
       CX=S1*FS(I)*C2
 3240  DNU=2.*DH*(1.+AX*DNK)
       AN=DNU/ABS(DNU)
```

```
 3220 CONTINUE
      BNU=ABS(BNU)
 3225 CONTINUE
      IF(BNU.LT.10.) BNU=10.
      BEX=BE*BNU**2*AX
```

```
      IF(BEX.GT.40.) GO TO 3025
```

```
      RD=1.0001-B**AQ/2./DN
      SD=BE*AT*BNU*CX/EXP(BEX)*ADD/RD
```

```
 3015 IF(SD.LT.1.) GO TO 3025
```

```
      SDX=SD/100000.
      SGH(J)=SGH(J)+SDX
      SXG=SDX/*S(I)/SDX
      SAH(J)=SAH(J)+SX2
```

```
 3025 IF(LSD.EQ.2) GO TO 3250
```

```
      IF(I.LT.3.OR.I.GT.6.AND.I.NE.14) GO TO 3250
```

```
3035 DNU=AV-AMD(I)+D*(I)

     IF(DNU.GT.DM) GO TO 3250

     DNY=SQRT(1.-DNJ/DM)
     CADD=1.
     IF(DNY.LT.DTT) CADD=(DNY/DTT)**(3.*P)
3265 DNJ=2.*DM*(1.+AX*DNY)
     A1=A1+CTT
     LOD=?

     GO TO 3230

3250 CONTINUE

1507 CONTINUE
C

3093 SDX=C.
     TAX=0.

     IF(NPRINT.LT.5) GO TO 1014
```

```
IF(NPRINT.NE.5) GO TO 4000

** INCLUDE CO AND N2O IN ATMOSPHERE

      PA=0.
      IPRINT=5
      DXS=0.

  300 IF(L.NE.1) GO TO 4010

      PA=PA+P*XS
      DXS=DXS+XS/TB

 4010 CONTINUE
      ISKA,D(I))*PA/VA

      DO 1  I=1,2

      DNU=ABS(A1-HNU(II))
      IF(DNU.LT.20.) DNU=20.
      AX=.002628*DNU
      IF(L.EQ.5) BX=BX/5.
      AZ=BY*DNU
```

```
      IF(BI.GT.50.) GO TO 1010

      SDX=BX*BL(1)*P3/EXP(BI)/10.

      IF(I.EQ.5) GO TO 1010

      SXW=SDX/GX
      HSX(L)=HSX(L)+SXW
      HSG(L)=HSG(L)+SDX

 1010 CONTINUE
      SDX=SDX*P3/DXS
      HSX(L)=HSX(L)+SDX
      HSG(L)=HSG(L)+SDX/GX

 1014 IF(SGH(J).EQ.0.) GO TO 1648

 1065 TAK=DSH(J)/SQRT(SXM(J)+1.)

 1648 TAK=TAK+TSK/TSC(L)
     1 +HSG(L)/SQRT(1.+HSX(L))
```

```
      IF(TAK.LT.80.) GO TO 1105
      TAK=0.
      GO TO 2095
 1105 CONTINUE
      TAK=EXP(-TAK)
 2095 RETURN
      END
```

(ENTRANCE)

```
TOT
      SUBROUTINE TOT(BUF1,BUF4,NDM,NC)
      COMMON/COM/USPEC,ANI(7),AME(7)
      DIMENSION BUF1(1)
       DIMENSION BC(7),CI(7),CE(7),AI(7),AE(7),BUF4(1)
      DATA NGO/1/
      M=2*NDM
  150 I=1

  160 J=2
      K=2

  170 IF(ANI(I).LT.BUF1(J)) GO TO 180

      J=J+1
      N=N+1

      GO TO 170

  180 IGO=1

      GO TO (185,190),NGO

  185 AI(I)=(BUF1(J)-ANI(I))**2/(BUF1(J)-BUF1(J-1))/2.
      CI(I)=((AI(I)-BUF1(J-1))*(BUF1(J)-ANI(I))/(BUF1(J)-BUF1(J-1))
     1 +BUF1(J+1)-ANI(I))/2.
      BC(I)=AME(I)-ANI(I)
```

```
  150 BUF4(M)=BUF4(M-1)+AT(I)
      MM=C(I,I)

      GO TO 220

  200 M=M+1
      J=J+1

      IF(BUF1(J+1).GE.ARE(I)) GO TO 250

      D4=(BUF1(J+1)-BUF1(J-1))*.5

  220 BUF4(M)=D4*BUF5(N)+BUF4(M)

      GO TO (200,300,230),IGO

  230 IF(BUF1(J+1).GE.ARE(I)) GO TO 250
```

```
      IJU=1

      GO TO 200

  250 GO TO (251,252),NGO

  251 AE(I)=(AME(I)-BUF1(J))**2/(BUF1(J+1)-BUF1(J))/2.
      CE(I)=((AME(I)-BUF1(J))*(BUF1(J+1)-AME(I))/(BUF1(J+1)-BUF1(J))
     1 +AME(I)-BUF1(J-1))/2.

  252 BUF4(M)=BUF4(M)+AE(I)*BUF4(M+1)
      DM=CE(I)
      IJU=2

      GO TO 220

  300 M=M+1
      I=I+1

      IF(I.LE.NSPEC) GO TO 160
```

```
      NQC=2
      IF(MC.EQ.0) RETURN
      MU=ND*+1
      IO=I-1

      DO 340 I=1,IO

      K=I+MO
       IF(MC.EQ.2) BUF4(K)=BUF4(K)/DC(I)

  340 WRITE(6,5008) AMI(I),AME(I),BUF4(K)
 5008 FORMAT(12X,4HFROM,F5.2,3H TO,F5.2,11H  MICRONS =,F12.4,7H  WT/SR)

      RETURN

      END
```

(ENTRANCE)

```
**EXEX
      SUBROUTINE FXEX
      COMMON/THK/TH(8),THA(10),EMS(8)
      COMMON/INSET/T7,TS,A8,P8,PAMB,TAMB,V10,XM,ALTI,FAR
       COMMON/CNT'N,BTS,FE,NAS
      COMMON/SURF/X1(8),Y1(8),X2(8),Y2(8),VECT(8),
     * TSURF(8),NODE(8),XP(2),NTOTL,NP(2),AREA(8)
     * ,F(8,8),XC(6),YC(6)
      DIMENSION FE(13,8)
      DIMENSION YF(2,5 ,HF(2,5)
       DIMENSION YFA(8),YFB(8),RFA(8),RFB(8)
      NNU=2
      NNNN=0
C       INITIALIZE FOR VIEW FACTOR CALCULATION

   30 CONTINUE
      I=7

   35 IF(Y1(I),NE,PTS) GO TO 140

      I=I-1
      IF(I,EQ,1) RETURN

      GO TO 35

C       EXTERNAL SURFACE COORDINATES

  140 DO 45 K=1,I
```

```
      IF(K,F9,1) GO TO 40

      VELT(K-1)=-1.
      X2(K-1)=X1(K)
      Y2(K-1)=Y1(K)
      ISURF(K-1)=1

40    VF(1,K)=X1(K)

45    DF(1,K)=Y1(K)+.015
      NP(1)=I
      IA=I-1
      WRITE(6,8020)
8020  FORMAT(1H1/10X,27HEXTENDED HUT PARIS GEOMETRY//)
      WRITE(6,8009)
8009  FORMAT(//10X,32HEXHAUST SURFACE COORDINATES, I4,//)
      WRITE(6,8010) (X1(L),L=1,I)
      WRITE(6,8010) (Y1(L),L=1,I)
8010  FORMAT(2X,8F8.2)
C
C        CENTERBODY SURFACE COORDINATES
C
      J=5

50    IF(XC(J).NE.PTS) GO TO 55

      J=J+1
```

```
      IF(J-1)65,65,50

 55   JM1=J-1

      DO 60 K=1,JM1

      X1(I)=XC(K)
      Y1(I)=YC(K)
      X2(I)=XC(K+1)
      Y2(I)=YC(K+1)
      YC(...)=1.
      ISURF(I)=2
      AQ=.015
       IF(YC(K).GE..015) AQ=0.
      XF(2,K)=XC(K)-AQ
      RF(2,K)=YC(K)-.015+AQ

 60   I=I+1
      N=I-1
       WRITE(6,8011)
 8011  FORMAT(//10X,27HCENTERBODY COORDINATES,IN.//)
       NOP=N
      IAP1=IA+1
      WRITE(6,8010) (X1(L),L=IAP1,N),X2(N)
      WRITE(6,8010) (Y1(L),L=IAP1,N),Y2(N)
      XF(2,J)=X2(N)-.015
      RF(2,J)=Y2(N)-.015
      NP(2)=J

      IF(X2(N).GE.X2(IA)) GO TO 90
```

```
      I=I-2
      X1(I)=X2(N)
      Y1(I)=Y2(N)
      NPR=I
```

```
 65   NUM=1
      VECT(I)=1
      X2(I)=X2(IA)
      Y2(I)=0.
```

```
      IF( .GT.1) GO TO 65
```

```
      X1(I)=0.
      Y1(I)=0.
```

```
 F5   XF(2,J)=X1(I)-.015
      XF(2,J+1)=X2(I)+.015
      RF(2,J)=Y1(I)
      RF(2,J+1)=Y2(I)
      TS=FF(I)*2
      LP(2)=J+1
```

```
 70   I=I+1
      Y2(I)=Y1(I)
      Y1(I)=Y1(IA+1)
      X2(I)=X1(I)
      X1(I)=X1(IA+1)
      IF(TW(I).EQ.BTS) TW(I)=T5
      VECT(I)=-1.
      I=I+1
      VECT(I)=1
      X1(I)=X2(NCP)
      Y1(I)=Y2(NCP)
      X2(I)=X2(IA)
      Y2(I)=Y2(IA)
      TW(I)=T7
      TPL=X2(NCP)
      N=N+1
```

```
C      VIEW FACTORS AND PROJECTED AREAS
       NAS=1

       IF(NOR.LT.9)GO TO 195

       WRITE(6,9000)

       STOP

  9000 FORMAT(20(2H -),/5X 43HTOO MANY NODES IN EXHAUST SYSTEM DEFINITION
      1 /20(2H -))

   195 IF(THA(NAS+1).GE.90.) GO TO 70

       NAS=NAS+1

       IF(NAS.NE.19) GO TO 195

    70 CONTINUE
       CALL VIEW(X1,Y1,X2,Y2,VECT,NODE,NTO(1),YF,NF,NP,NNN,F,
      1 AREA,1)
       CALL SHADOW(NNN,NP,YF,RF,NF,YFA,YFB,RFA,RFB)
       CALL RZOTI(X1,Y1,X2,Y2,VECT,NTOTI,NF,RFA,RFB,YFA,YFB,NODE,
      1 TPL,NAS,NNN,THA,1,FE)

       RETURN
```

(ENTRANCE)

```
      SUBROUTINE VIEW(YUA,RUA,YDA,RDA,VECTA,NODEA,NTOT,YF,RF,NP,NSHO,
     1FFSR,AREI,PRINTO)
      DIMENSION NP(2),YF(2,5),RF(2,5),
     * PHIM(5),PHLO(5),PHICU(5),PHILL(5),PHIS(5),PHAM(5),
     * PHILL(5   ,PIUU(5),PHIMA(5),PHAMA(5),F(2,2),
     * FFSR(8,8),AREI(1)
      DIMENSION YUA(1),YDA(1),RUA(1),RDA(1),VECTA(1),NODEA(1),
     * A(2),DIV(2)
      DIMENSION YU(2),YD(2),RU(2),RD(2),VECT(2),NODE(2)
         EQUIVALENCE(II,JJ)

      DATA PIE/3,141592653898/
      PHI=.A873
15020 LIMIT=4
```

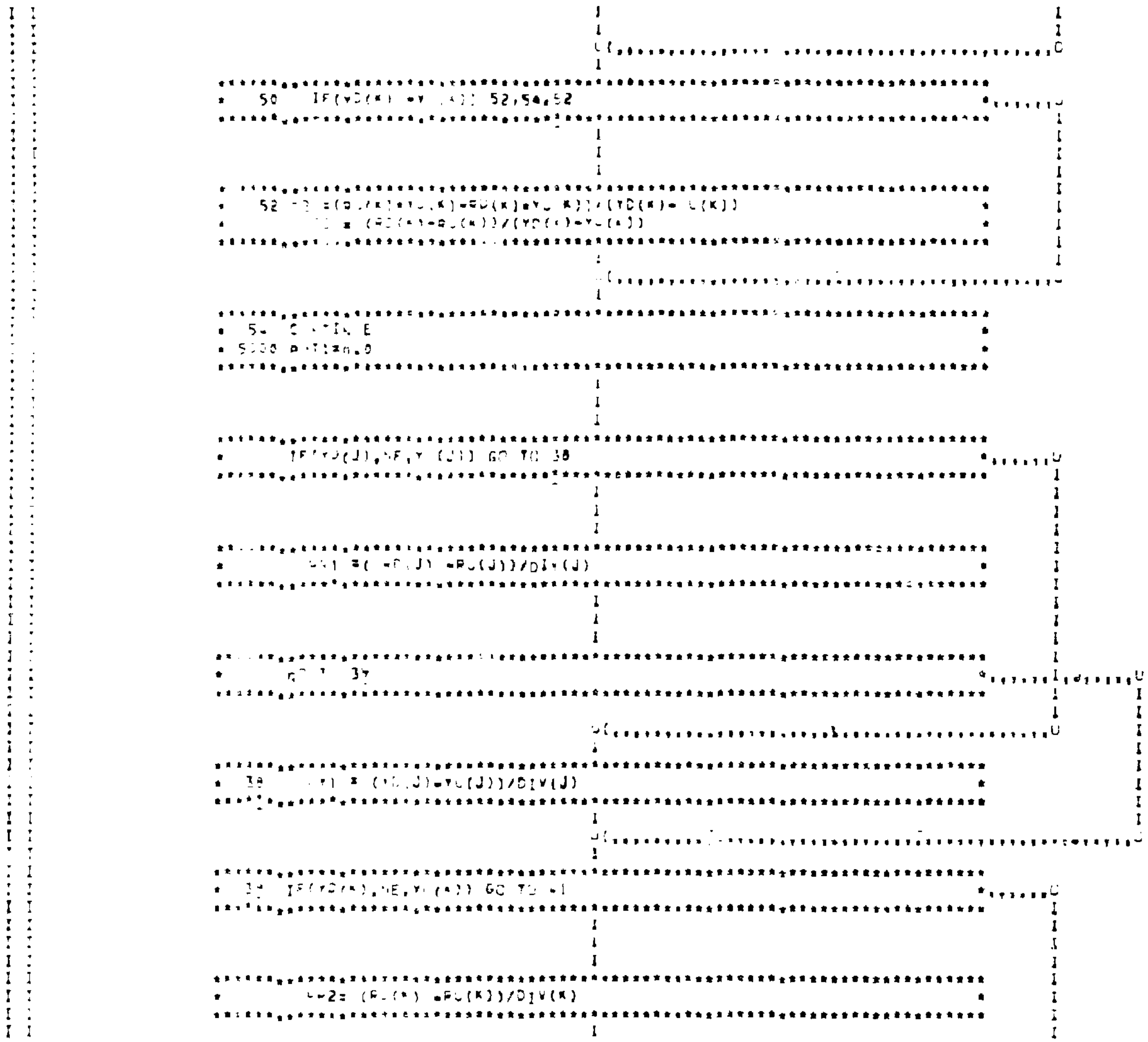
```
      DO 10000 IUI=1,NTOT
```

```
      YU(1)=YUA(IUI)
      YD(1)=YDA(IUI)
      RU(1)=RUA(IUI)
      RD(1)=RDA(IUI)
      VECT(1)=VECTA(IUI)
      NODE(1)=    EA(IUI)
   15   J=1
      A1=SQRT((YD(J)-YU(J))**2 + (RU(J)-RU(J))**2)
        A(J) = PIE*(RU(J) +RD(J))*A1
        =(YD(J)-YU(J))/A1
        = -(RD(J)-RU(J))/A1
```

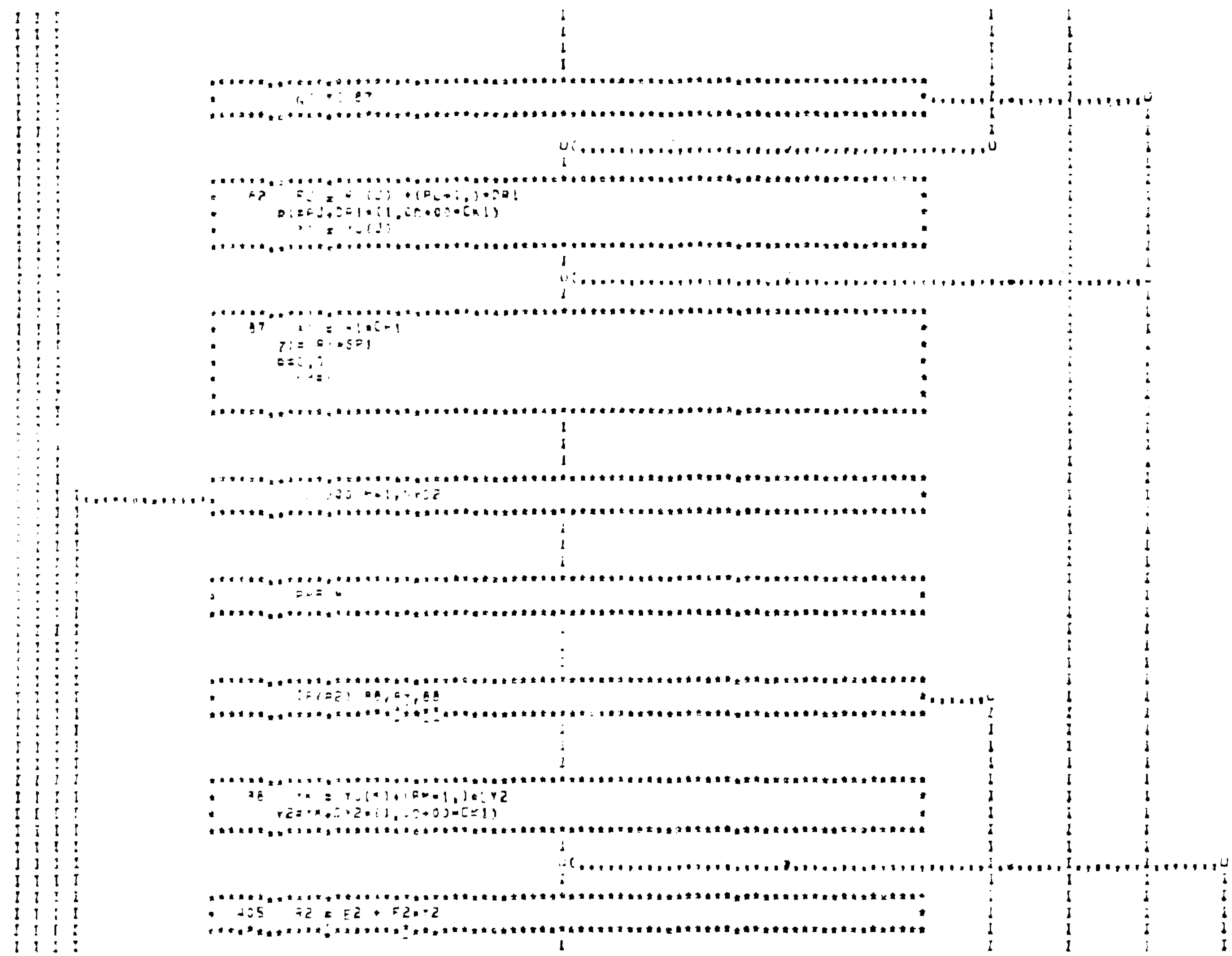
```
      IF(VECT(J) ) 20,30,30
```

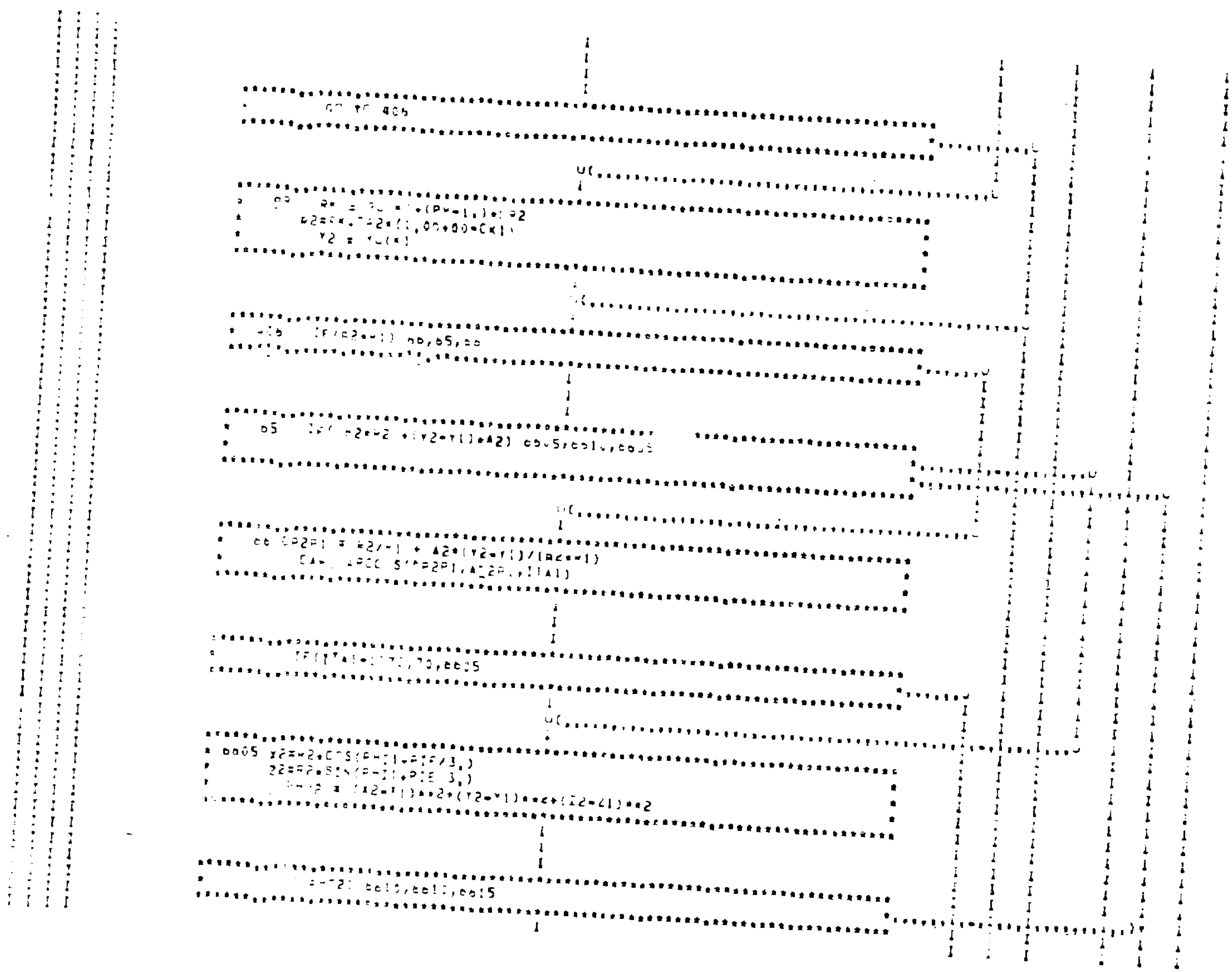
```
   20   B1 = -B1
        A1=  -A1
```

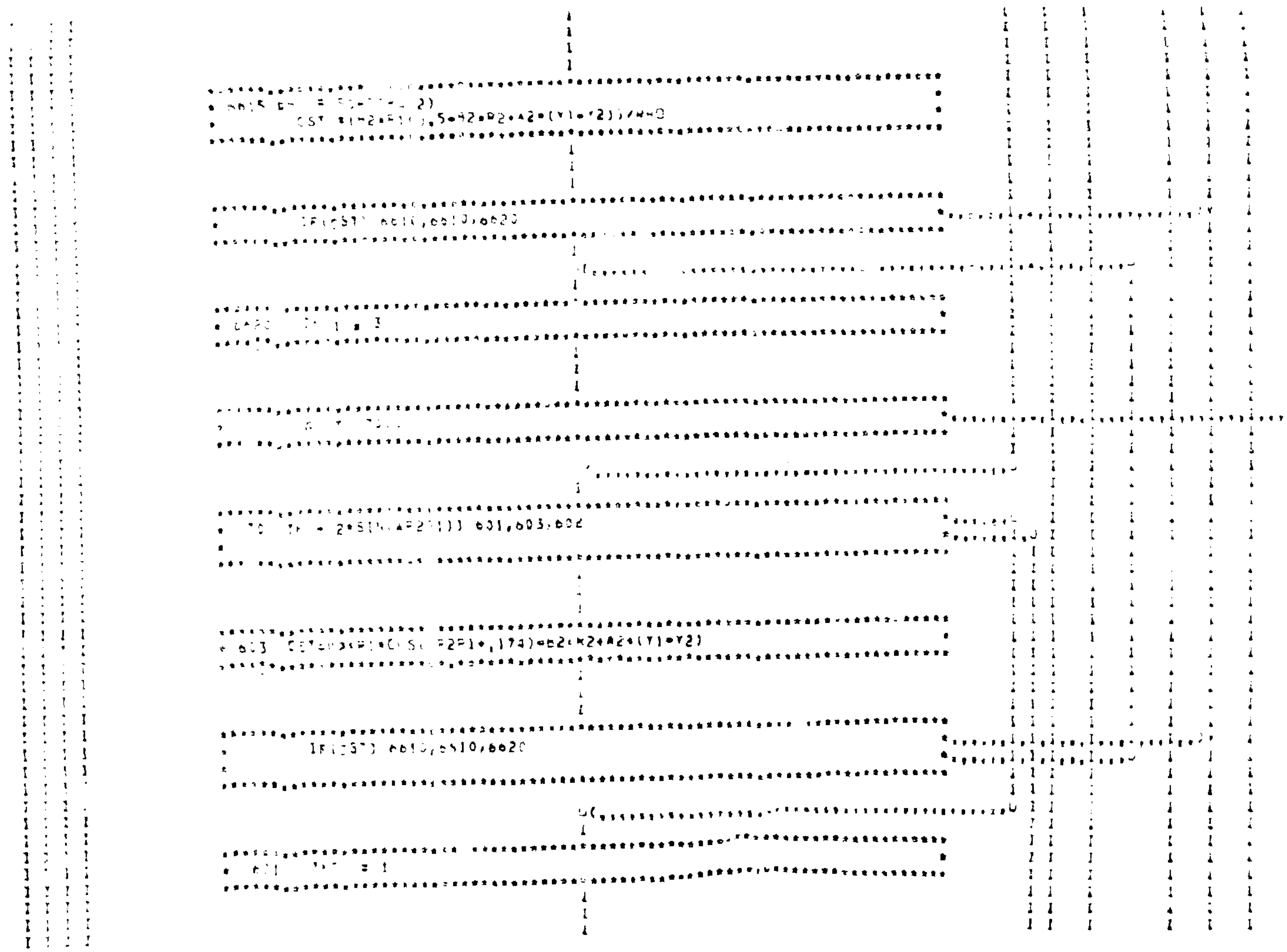
```
30 IF(YD(J) -YU(J)) 32,34,32

32 E1 =(RU(J)*YD(J)-RD(J)*YU(J))/(YD(J)-YU(J))
   H1 = (RD(J)-RU(J))/(YD(J)-YU(J))

34 CONTINUE

   DO 15000 JUJ=IUI,NTOT

      DIV(1)=1.0
      DIV(2)=1.0
      YU(2)=YUA(JUJ)
      YD(2)=YDA(JUJ)
      RU(2)=RUA(JUJ)
      RD(2)=RDA(JUJ)
      VECT(2)=VECTA(JUJ)
      NODE(2)=NODEA(JUJ)
361    K=2
      A2=SQRT((YD(K)-YU(K))**2 + (RU(K)-RU(K))**2)
        A(K) = PIE*(RU(K)+RD(K))*A2
      B2 =(YD(K)-YU(K))/A2
         A2 =(RD(K)-RU(K))/A2

      IF(VECT(K))40,50,50

40 B2= -B2
   A2= -A2
```


50 IF(YD(K) 52,54,52
GO TO 38
38
GO TO

```
      GO TO 56

 41      Y2 = (Y'(K) -YC(K) )/DIV(K)

 56   EF=0.0
         NYD1 = DIV(J)
         NYD2 = DIV(K)
         LL=1
 77   SPI = SIN(PHI(I))
      CPI = COS PHI(I)

      DO    LPI,NYD1

         PL = L

         IF(X1) 81,82,80

 80   Y1=  YC(J) +(PL-1.)*DY1
      Y1=YC+DY1*(1.0D+00-CK1)

 85   E1 = E1 + Y1*H1
```


405 R2 = E2 + F2*Z2


GO TO 405
Y2 = YU(K)
66,65,66
65
665,661,665
CALL
6605
8815



CST =(H2*P1(),5*H2*P2+A2*(Y1*Y2))/HHO
IF(CST) 6610,6610,6620
IF(CST) 6610,6510,6620

```
      GO TO 7001

 6?2  ???? = 2

 7??1 IF( R1+R2) 72,7010,72

 7010 IF( (Y2-Y1)*A1 +R1*B1) 7030,7040,7030

 72   ?P2P1 = R1/R2 +A1*(Y2-Y1)/(B1*R2)
      CALL ARCC 3(?P2P1,RP2P1,ZTA1)

      IF(ZTA1-1.)7?,9?,7030

 7?30 Y2=R2*COS(PHI1+PIE/3.)
      Z2=R2*SIN(PHI1+PIE/3.)
      RH?2 = (X2-X1)**2+(Y2-Y1)**2+(Z2-Z1)**2

      IF(RHO2: 70?   ???,7050

 7050 RH =SQRT(RH 2)
      CST = (R2*A1+0.5 *R1*B1 +(Y2-Y1)*A1)/RHO
```

```
IF(CST) 7040,7040,7060

7060    N?P = 3

[illegible] 9001

[illegible] IF([illegible](SIN(BP2P))) 901,903,704

[illegible]3 [illegible]T=[illegible]2*L SI[illegible]P2P) + .174) =5)*R)*(Y2=Y1))*A1

IF(CST) 7040,7040,7060

901   INCP = 1

GO TO 9001

902   INCP = 2
```

```
9001   GO TO(910,920,930), IND1

 910   GO TO(940,950,960),IND2

 920   GO TO(970,980,990), IND2

 930   GO TO(977,988,999),IND2

 940   IF(AP2P1-BP2P1) 960,960,977

 950   IF(AP2P1 -BP2P1)  9010,9010,9012

9012   PHIU = AP2P1
       PHIL= BP2P1
```

```
      GO TO 98

 980  PHI = AP2P1
        P·I=P?.0

      GO TO 98

 970  IF(AP2P1 -AP2P1) 9014,9010,9010

 9014  PHI = AP2P1
       PHI = AP2P1

      GO TO 98

 960  IF((P2P1 -..2P1)  998,985,970

 970  PHI = PIE
      PHI = AP2P1

      GO TO 98
```

```
977   PHI =0,0D+00
      PHI  = SP2PI

      GO TO 98

988   PHI = PP2PI
      PHI  = PIE

      GO TO 98

999   PHI =0.0
      PHI = PIE

98    LOKE= 0
      LOPPY= 0
      LOIK= 0

      DO 1295  II=1,NSHB

      CALL FINDIT(Y1,YF,II,NP(II),NY1)
      CALL FINDIT(Y2,YF,II,NP(II),NY2)
      CALL CODE(NY1,NY2,NP(II),IC)
```

```
      IF(ABS(Y1-Y2)-1.0E-3) 1240,1240,1250

1240  IF(I[illegible]) 1295,1295

1900  XF = [illegible]
      YF = [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible](YFD-YFU)
      [illegible]

      IF([illegible]-1.0E-001) 1295,1295,1920

1920  IF(ABS [illegible]-2)-0.001) 1295,1295,1930

1930  IF(P1-PC1) 1950,1940,1960

1940  IF(P2-PC1) 7130,1970,1970

1950  IF(P2-PC1) 1295,1295,7130
```

```
1970  AAF=1.0
      BBF= -2.*RC1**2/(R1*R2)
      CCF= RC1**2*(R2**2+R1**2)/(R1*R2)**2  -1.0
      CALL QUAD(AAF,BBF,CCF,RR11,RI11,RR22,RI12,IDH1)

      GO TO (1980,2000,1295,1295),IDH1

1980  CALL ARCCOS(RR22,PHI1,ITA1)

      IF(ITA1-1) 1990,1990,2000

1990  CALL TEST1(R1,R2,PHI ,PHI1,X1,Z1,I1S1)

      IF(I1S1-1) 2030,2030,2000

2000  CALL ARCCOS(RR11,PHI1,ITA1)

      IF(ITA1-1) 2010,2010,12..
```

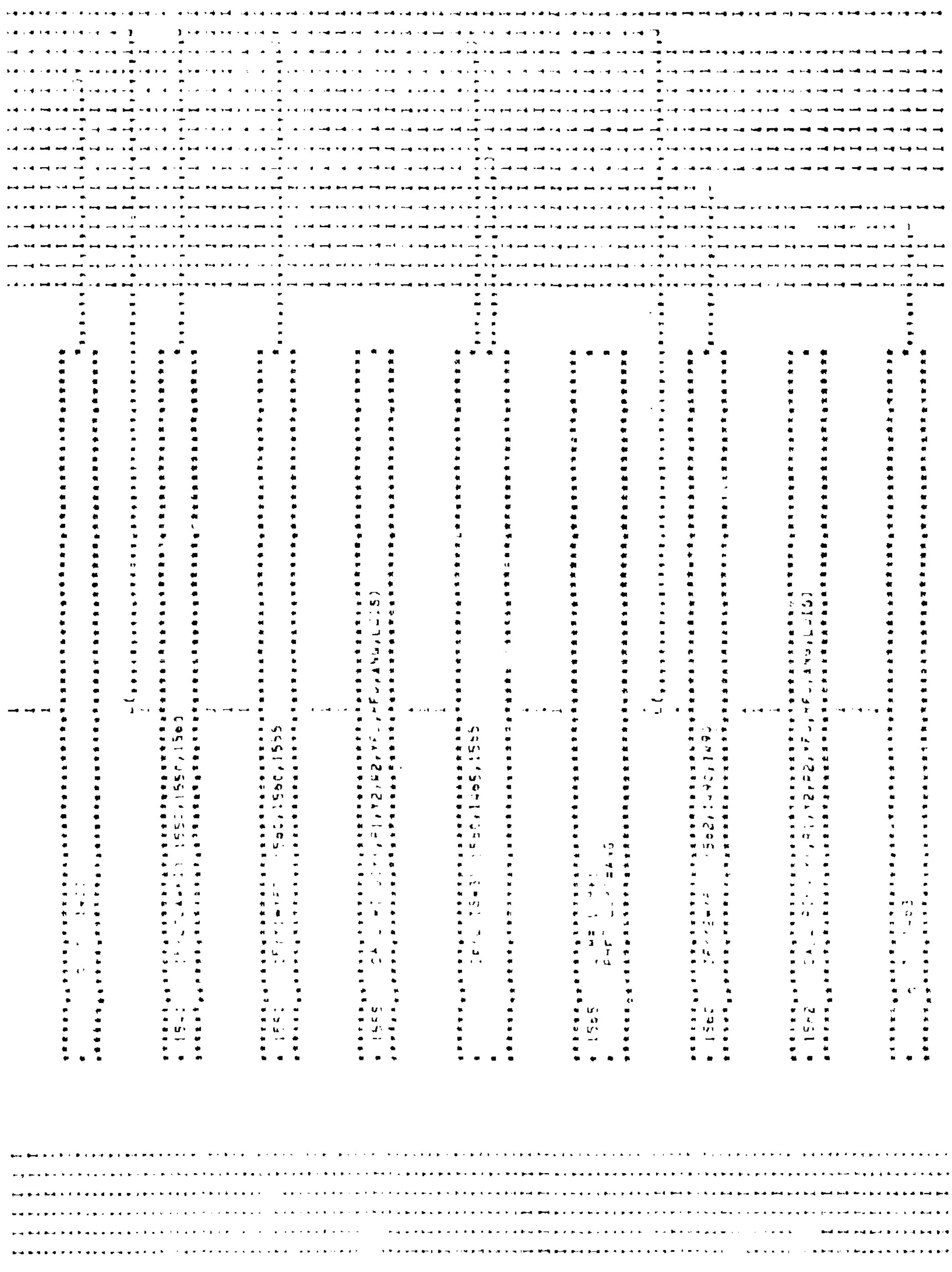
```
2010  CALL TEST1(R1,R2,PHI0,PHI(I,K1,K2,I(9)))

      IF (ITS)=1) 2030,2030,1295

2030  [illegible]
      PHI(I,K1) = PHI0

      GO TO 1295

1250  GO TO (1260,1265,1270,1275,1280,1285,1290,1295),IC

1260  KI = 1
      KILK NP(III) = 1

      GO TO 1300

1265  KI = 1
      KIG = NY2
```

```
      GO TO 1300

1270  KI=1
      KIL= NY1

      GO TO 1300

1275  KI=NY1
      KIL= NP(III)+1

      GO TO 1300

1280  IF(Y(I+Y2) 1310,1310,1315

1310  KI=NY1
      KIL = NY2

      GO TO 1300
```

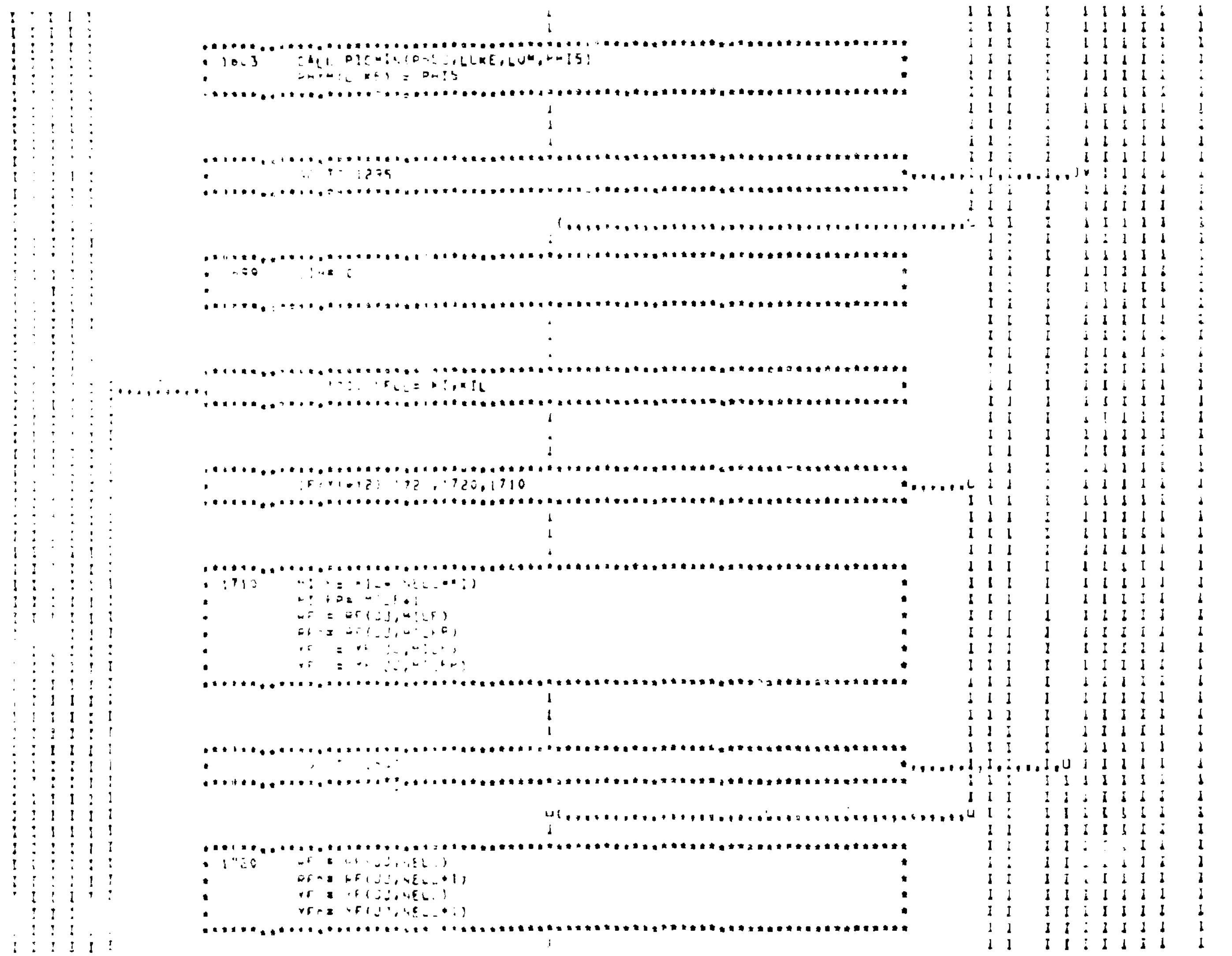
```
1335  KI= NY2
      KIL= NY1

      GO TO 1300

1285  KI= NY2
      KIL= NP(II) -1

1300  CALL DANSHE(Y1,P1,Y2,P2,..,..,K1,KIL,II,ISEE)

      ... 1285,1369,1697,7130,1397),ISEE

1397  ...= 0

      ... 1400  ... AX KI,KIL

      IF(...Y2) 1420,1420,1410
```

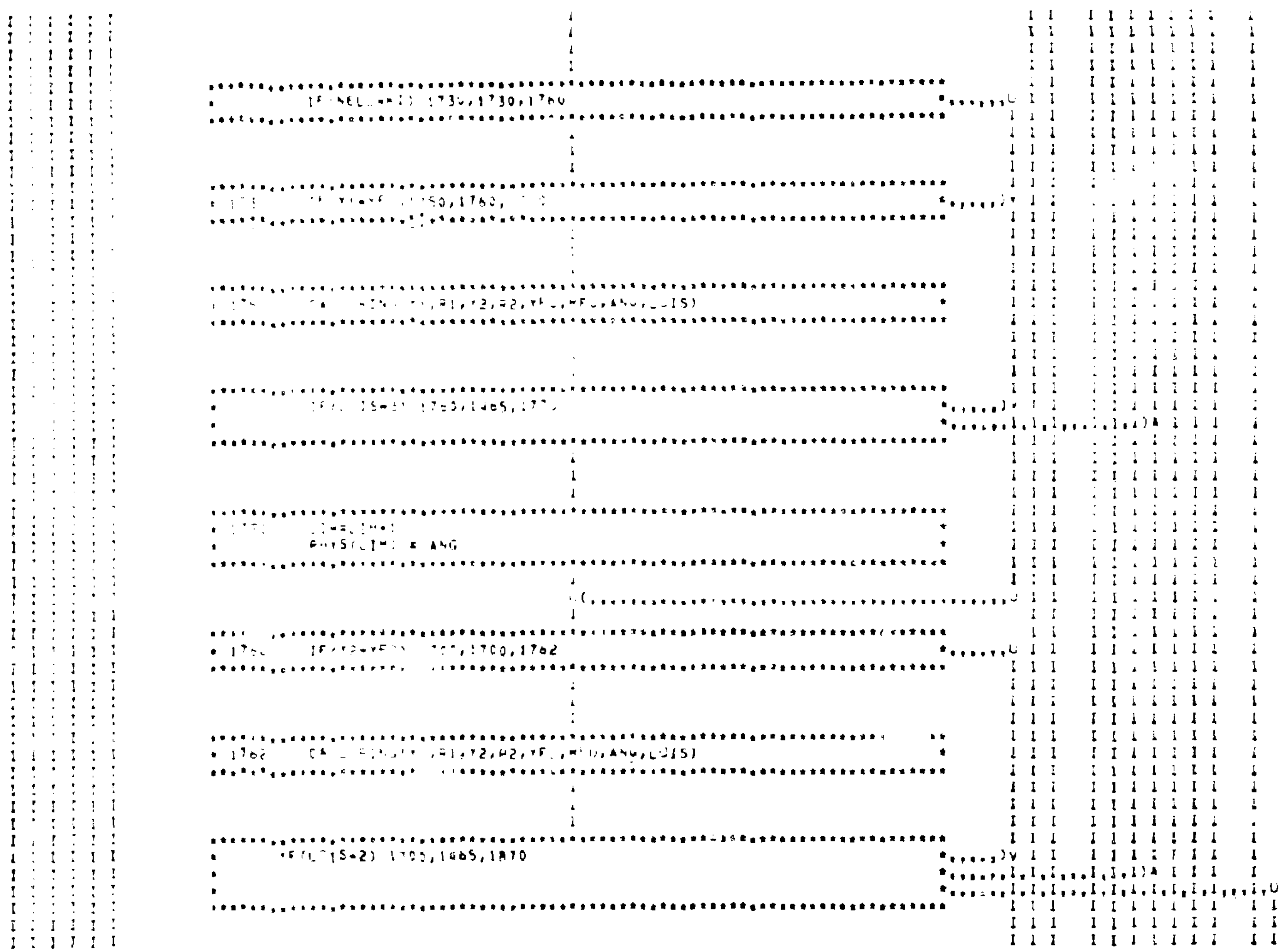
```
1410   XI FX*IL* [illegible] LA+1)
       XI [illegible] = [illegible]
       XF =PF [illegible]
       XFH =PF(JJ,KIL,P)
       YF = YF(JJ,KIL[illegible])
       YFH= YF(JJ,KIL,P)

       GO TO 1540

1420   RF =RF(JJ,LA)
       RFH= RF(JJ,LA+1)
       YF = YF(JJ,LA)
       YFH= YF(JJ,LA+1)

       IF(L[illegible]LA+1) 1430,1430,1440

1430   IF(Y[illegible]YF[illegible]) 1450, 460,1460

1450   CALL RIN[illegible](Y1,R1,Y2,R2,YF,RF,ANG,L,IS)

       IF(LCTS-3) 1460,1465,1470

1470   LC = LC+1
       RTF[illegible] = ANG
```

```
1440 CONTINUE

1460   IF(Y2-YFT) 1480,1470,1462

1462   CALL ROOT(Y1,R1,Y2,R2,YFL,RFL,ANSL,IS)

1463   GO TO (1400,1400,1465,1500),IS

1500   LM=LM+1
       PHF(LM)= ANS

1470 CALL ROOT(Y1,Y2,R1,R2,YFU,RFU,YFL,RFL,PHIU,PHIL,IUN)

1525   IF(IDM-2) 1400,1510,1400

1510   LM=LM+1
       PHF(LM) = PHIC
```

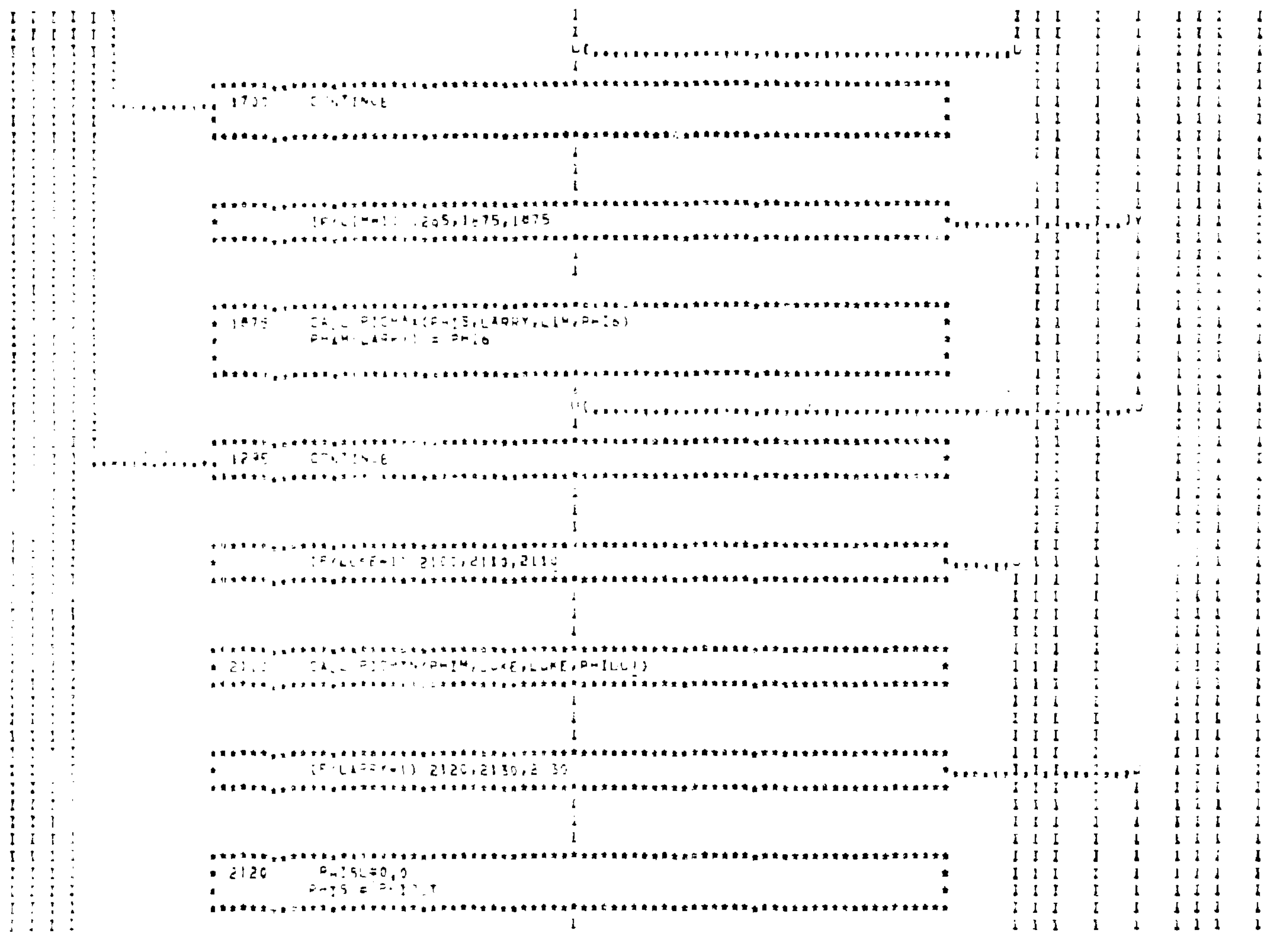


```
1600    CONTINUE

        IF(L-M+1) 1295,1601,1601

1601    WRITE(6,1650)
1650    FORMAT(1H1,////,9X,52HTHE ANGLE FOR THE LIMIT OF INTEGRATION IS LA
       1RGER (,,,,2X,30HTHE D SIDE IS GREATER THAN 1,/,25X,29HPHUGHAM S
       2TOPPED IS STOPPED, //,30X,17H(SUBROUTINE RING) )

        STOP

1601    IF(IFEL-5) 1603,1602,1602

1602    CALL PICMAX(PHEC,LOCK,LOM,PHIA)
        PHEC(LOCK) = PHIA
        LOM= LOCK
        CALL PICMIN(PHEC,LOCK,LOM,PHIA)
        PHEC(LOCK) =PHIA

        GO TO 1295
```

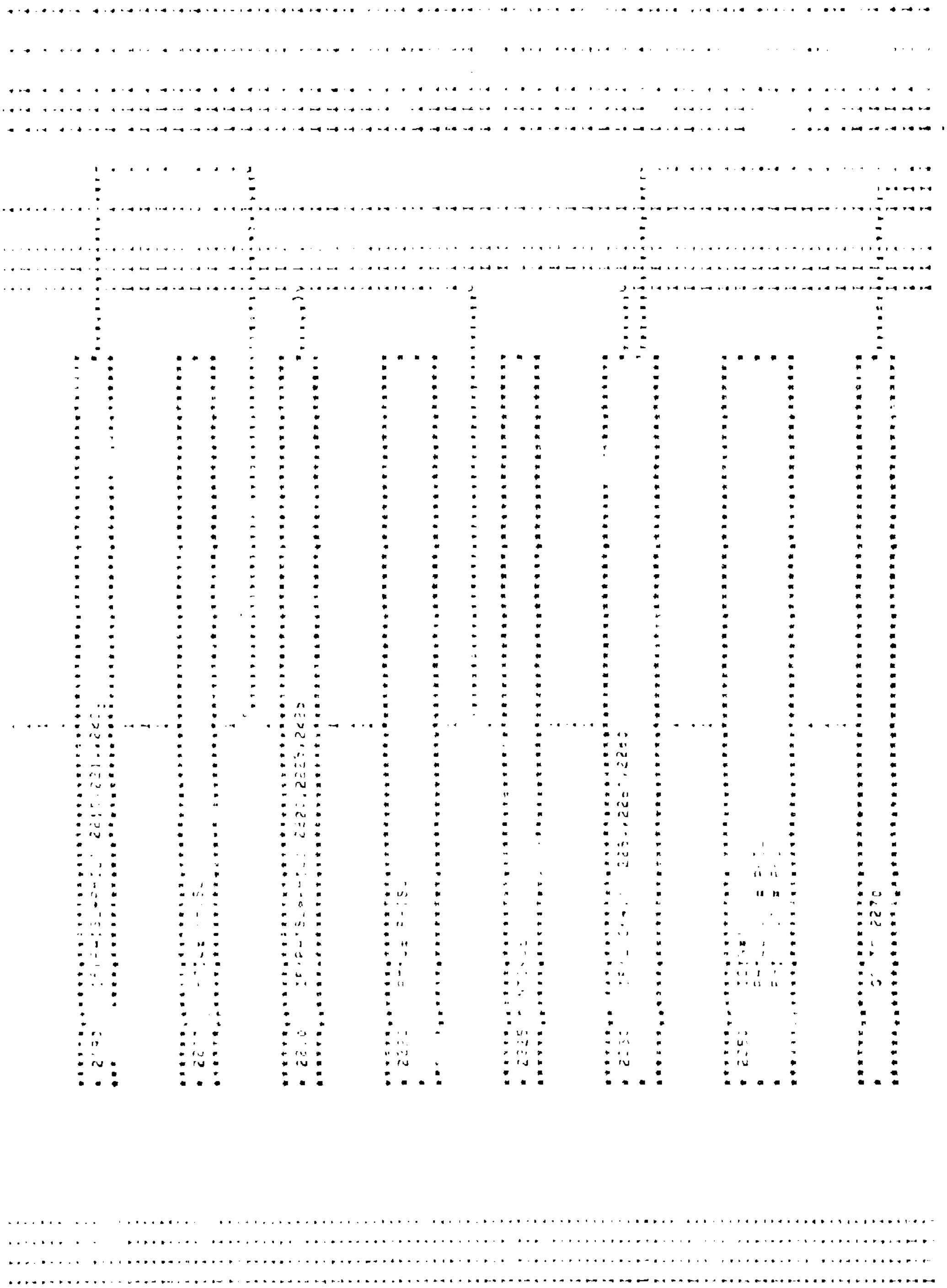

1710


1730,1730,1760
1750,1760,
R1,Y2,R2,
IS)
PHYS
ANG
1700,1762
1762
Y2,R2,
ANG,
S)
S-2)
1665,1870

```
1840   IF(NELL-KI) 1850,1850,1860

1850   IF(Y1-Y2) 1860,1860,1855

1855   CALL FINDG(Y1,R1,Y2,R2,YFD,HFC,ANG,LUIS)

       IF(LUIS=3) 1860,1865,1865

1865   LIM=LIM+1
       PHYS(LIM)= ANG

1860   IF(Y2-YF) 1862,1700,1700

1862   CALL FINDG(Y1,R1,Y2,R2,YFD,HFC,ANG,LUIS)

       GO TO (1700,1700,1865,1870),LUIS

1870   LIM=LIM+1
       PHYS(LIM)= ANG
```


1730 CONTINUE
IF(LIM-1) 1295,1875,1875
1875 CALL PICMAX(PHIS,LARRY,LIM,PHI6)
PHIM(LARRY) = PHI6
1295 CONTINUE
IF(LUKE-1) 2100,2110,2110
2100 CALL PICMIN(PHIM,LUKE,LUKE,PHILU)
IF(LARRY-1) 2120,2130,2130
2120 PHISL=0.0
PHIS = PHISLT

```
        GO TO 2140

2130    CALL PICMAX(PHAM,LARRY,LARRY,PHIIN)

        IF(PHI LT.PHIIN) 7130,7130,2150

2150    PHISL=PHIIN
        PHIS =PHIOUT

        GO TO 2140

2100    IF(LARRY-1) 2225,2160,2150

2160    CALL PICMAX(PHAM,LARRY,LARRY,PHIIN)
        PHISL=PHIIN
        PHIS = PIF

2140    IF(PHI -PHISL) 7130,7130,2180

2180    IF(PHIS -PHIL) 7130,7130,2190
```



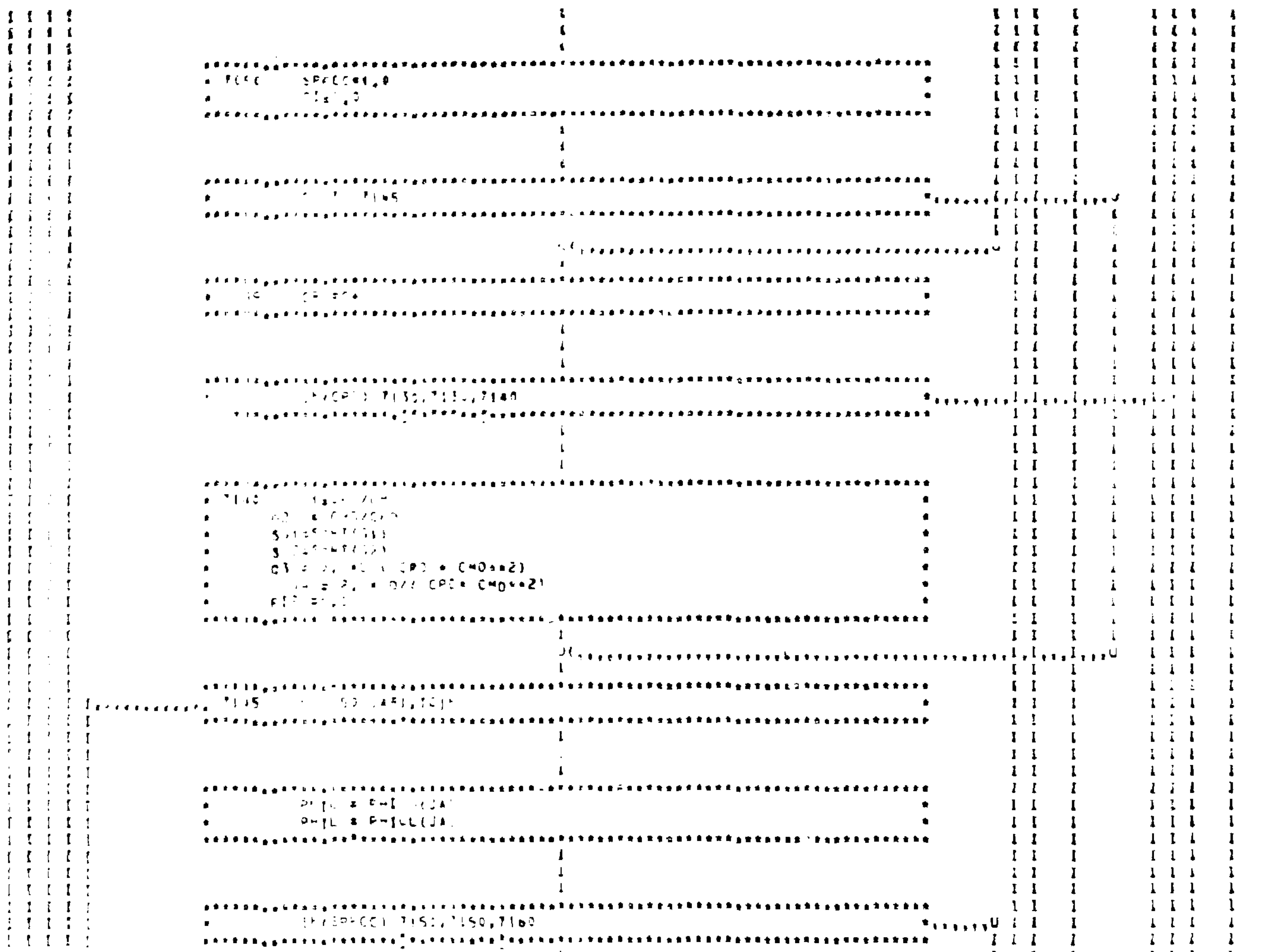
```
2280    LOCKM= LOCK-1

        DO 2290 IPH=1,LOCKM

        IPH1= IPH+1

        DO 2290 JPH= IPH1,LOCK

        IF( PHICL(IPH)-PHICL(JPH)) 2290,2290,2300

2300    TEMP= PHICL(IPH)
        PHICL(IPH) = PHICL(JPH)
        PHICL(JPH) = TEMP
        TEMP= PHICU(IPH)
        PHICU(IPH) = PHICU(JPH)
        PHICU(JPH) = TEMP

2290    CONTINUE

2260    LOCK= 1
        PHIMA(LOCK) = PHICL(1)
        PHIMI(LOCK) = PHICU(1)
        JG= 2
```

```
2370    IF(JG-LOCK) 2320,2320,2330

2320    CALL TEST2 (PHIMA(LOCK),PHAMA(LOCK),PHICL(JG),IPP)

        IF(IPP-1) 2340,2340,2350

2340    CALL TEST 2 (PHIMA(LOCK),PHAMA(LOCK),PHICL(JG),IPP)

        IF(IPP-1) 2360,2360,2340

2390    PHAMA(LOCK) = PHICL(JG)

2360    JG=JG+1

        GO TO 2370

2350    LOCK=LOCK+1
        PHIMA(LOCK) = PHICL(JG)
        PHAMA(LOCK) = PHICL(JG)
```

```
      GO TO 2300

2330  ICYN=0
      JI=1
      PHILL(I)=PHIL

2390  IF(JI-LICK) 2410,2410,2420

2400  PHILL(I)= PHIL
      ICYN=1

      GO TO 2270

2410  IF(PHIMA(JI)-PHIL) 2480,2440,2430

2440  IF(PHIMA(JI)-PHIL) 2460,2450,2450

2450  IF(PHIMA(JI)-PHIL) 2480,7130,7130
```

```
2460   JJ=JJ+1

       [illegible] TO 2390

2430   IF(PHIMA(JJ)-PHI[illegible]) 2432,2431,2431

2431   PHI[illegible]=PHI[illegible]
       [illegible]

       [illegible] TO 24[illegible]

2432   PHI[illegible]  = PHIMA(JJ)
       [illegible]

2470   IF(PHIMA(JJ)-PHI[illegible]) 2480,2470,2470

2480   [illegible] [illegible]
       PH[illegible]  = PHAMA(JJ)

       IF([illegible]) 2490,2500,2500
```

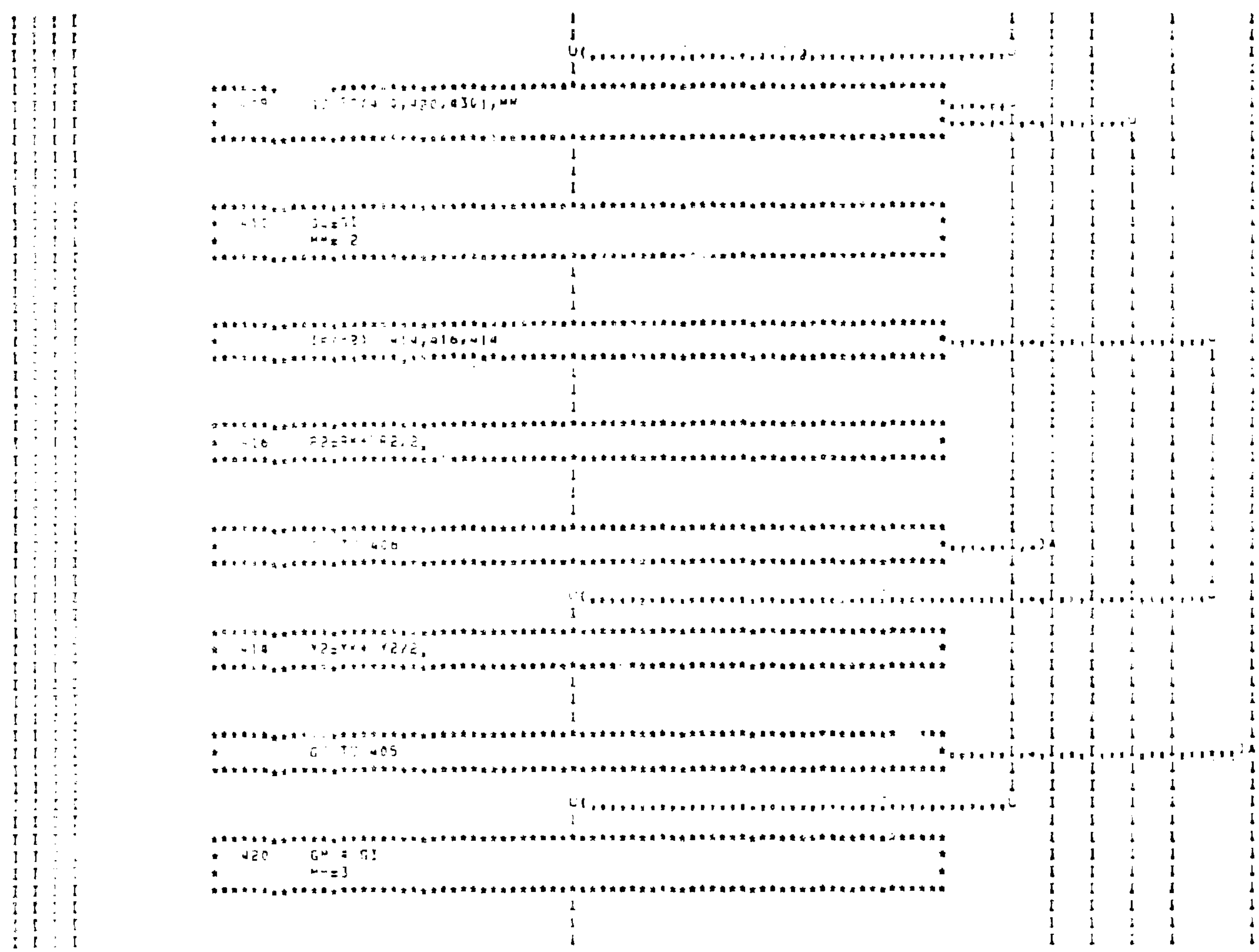
```
2490   JI= JI+1

       IF (PHI -PHIMA(JI) ) 2500,2500,2510

2500   PHI (IC(N)) = PHIMA(JI)

       GO TO 2470

2370   PHI(IC(N)) = PHI

2270   D2 = R2**2 + [illegible]**2 + (Y2-Y1)**2
         [illegible] = R2, [illegible]
         [illegible] = [illegible]
         SPEC=0.[illegible]

       IF(CM-1,CE-5) 7070,7070,99

7070   IF(R1 ? 3),7130,7090
```



```
1150   IF   PHIL -PIE) 100,110,110

100   S 2=S N(PHI /2.)
      C 2=C S(PHI /2.)
        T 2 = S 2/C 2
         AT 2 = S   *T 2
      A =AT   AT
        TF  = T      + G1*T 2*T 2)

        T  120

110     AL = PIE 2.
        TS =1.

120     IF PHIL  135,135,130

130   SL2=SIN(PHIL/2.)
      CL2=COS(PHIL/2.)
        TL2 = SL2/CL2
         ATL2 = S  *TL2
      AL=AT  (ATL2)
        TS  =  TL2   1.  + G1*TL2*TL2 )
```

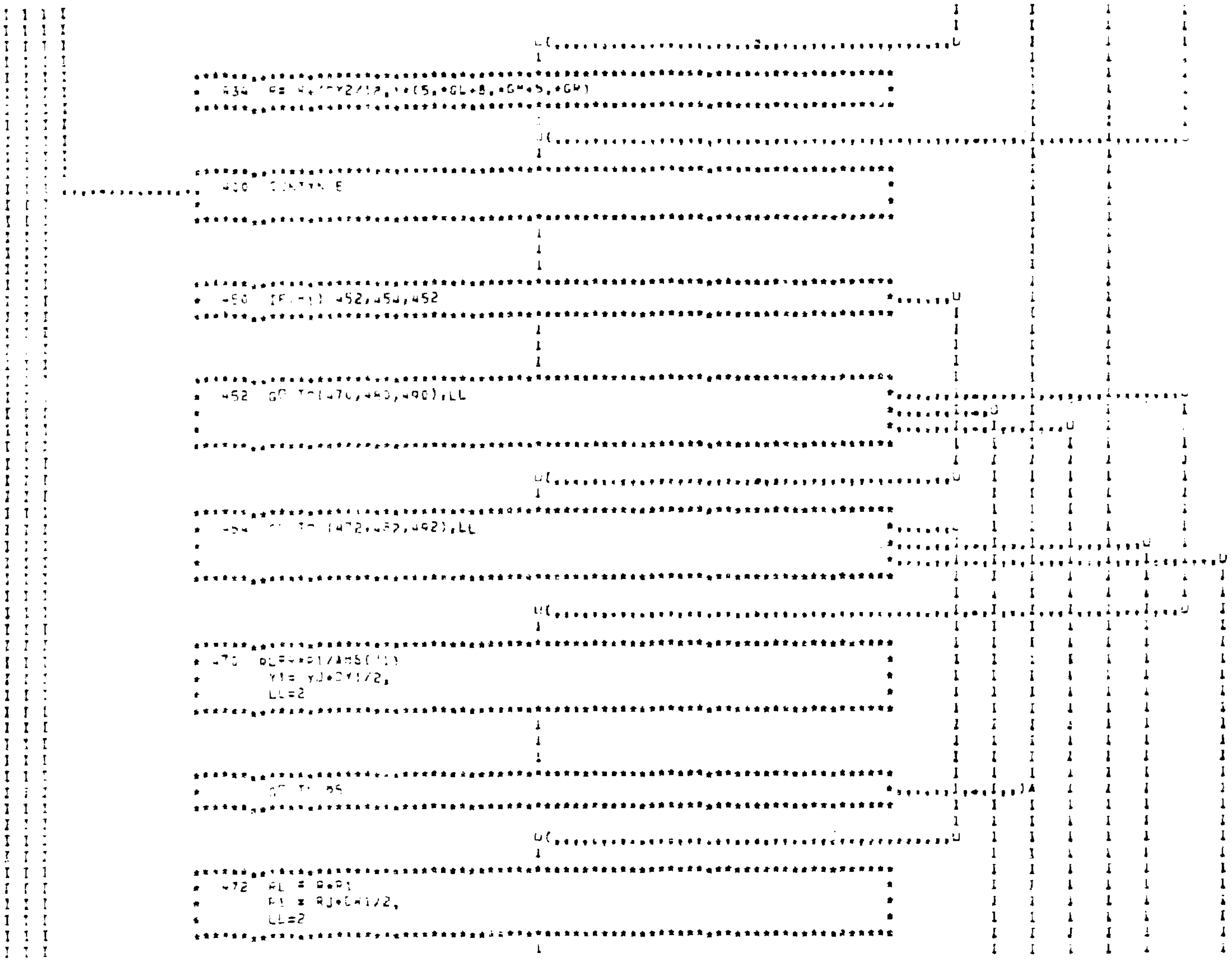
```
      GO TO 140

135   ALFT,0
      ELF=0,0

140   E11 = SS2*.R*(AL -AL) + G*(G5L-G5L)
      E12 = SS2*D*(AL-AL) + G3*(G5U-G5L)
      E14 = ... *(PHIU -PHIL) +(G3*(2,*J*J -C*C)/D**2)*S2*
     1 AL ... *(G5U-G5L)
      C1 = ... **2
      C12 = ... *(Y2-Y1)*B1+ ... *(Y2-Y1)
      C1= ... *(Y2-Y1)*A1*A2*(Y2-Y1)*
     1 **2
      F1=0 = C1*E1+C12*E12+C13*F11+E120

      GO TO 150

7150  ... *(PHIU-PHIL)/(2.*PIE*R1)

150   CONTINUE

      IF(SPEED) 279,299,409
```

```
299     IF(R2) 310,300,310

9010 CONTINUE

7?40 CONTINUE

8010 CONTINUE

7130 ...

        ...  LOOP

300     ... = 2.*-2*EI2)/PIE

        ...  LOOP

310     ... =2.*-2*EI20/,PI=*ABS(R2))
```



MM= 2
420
GM = GI

```
      IF(32) 424,426,424

426   P2=P+CR2*C*1

      GO TO 406

424   Y2=Y+C*Y2*C*1

      GO TO 415

430   GR=RGI
      W=1

      IF(R2) 434,436,434

436   RR=(CR2/10.)*(5.*GL+9.*GM+5.*GW)

      GO TO 400
```


(5,*GL+8,*GM+5,*GR)
452,454,452
452
(472,482,492),LL
LL=2
472
LL=2

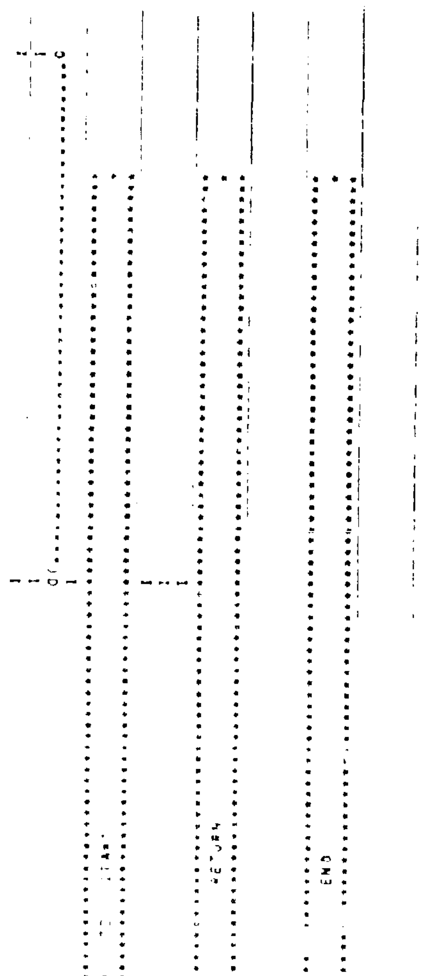
```
      GO TO 87

480   RM= R*R1/DABS(B1)
      Y1=Y1+DY1*CK1
      LL=3

      GO TO 85

482   RM= R*R1
      R1=RJ+DR1*CK1
      LL=3

      GO TO 87

490   RR= R*R1/DABS(B1)
      FF=FF+(DY1/18.)*(5.*RL+8.*RM+5.*RR)
      LL=1

      GO TO 500

492   RR=R*R1
      FF=FF+(DR1/18.)*(5.*RL+8.*RM+5.*RR)
      LL=1
```

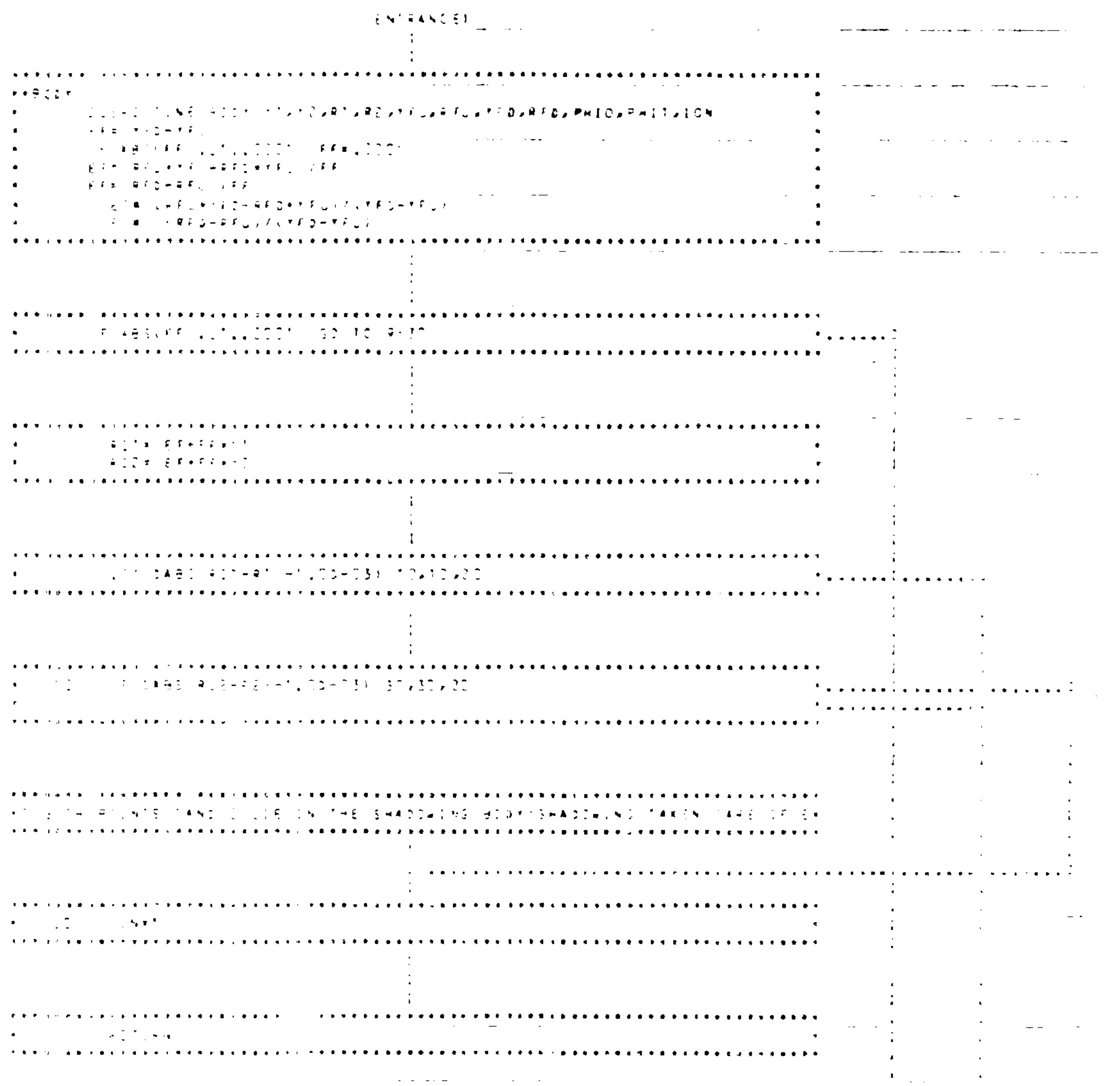
```
  500 CONTINUE

  600     F(J,K)= FF*2.*PIE/A(J)
          F(K,J)= F(J,K)*A(J)/A(K)
  641 IF(F(J,K) .LT. 0.0D+00) F(J,K)=0.0D+00
      IF(F(K,J) .LT. 0.0D+00) F(K,J)=0.0D+00
      NOD1=NODE(J)
      NOD2=NODE(K)
      FFSR(NOD1,NOD2)=F(J,K)
      FFSR(NOD2,NOD1)=F(K,J)

15000 CONTINUE
      AREI(NOD1) = A(J)/144.0

10000 CONTINUE
      WRITE(6,1502)
 1502 FORMAT(//26X,23HSYSTEM INTERNAL VIEW FACTORS//)

      DO 16001 I=1,NTOT

      DO 16000 J=1,NTOT

16004 WRITE(6,650) I,J,FFSR(I,J),J,I,FFSR(J,I)
  650 FORMAT(18X,2HF(,I2,1H,,I2,3H)= ,F7.5,10X,2HF(,I2,1H,,I2,3H)= ,F7.5)

15000 CONTINUE
      LINET=LINET+1
      ARE2=AREI(I)*144.0
      WRITE(6,15005) I,ARE2
15005 FORMAT(28X,5HAREA(,I2,3H)= ,F7.2,8H SQ. IN.,//)
      LINET=LINET+2
```

```
600 CONTINUE

670 RETURN

END
```

```
(ENTRANCE)

ARCCOS
      SUBROUTINE ARCCOS(CS,ANG,ITA)
      DATA PIE/3.14159265398
      T=ABS(CS)-1.0

      IF (T) 67,6601,6602

6601  IF(CS) 6603,6603,6604

6603  ANG = PIE

      GO TO 72

6604  ANG = 0.

      GO TO 72

6602  IF(ABS(T-1.0)   6601,6601,6605
```

```
C        NO SOLUTION

6615     ITR=2

         RETURN

   67    IF(CS) 67[illegible],6710,6720

6710     ANG = PIE/2.

         GO TO

6720 YP2=(SQRT(1.0-CS**2))/CS
         ANG=ATAN(YP2P1)

         IF (YP2P1) 60,70,70

   60    ANG = ANG+ PIE)
C        A SOLUTION WAS FOUND
```


END



ENTRANCE)
*BODY
[illegible] BODY [illegible] RFD,PHIO,PHIT,ION
[illegible] IN THE SHADOWING BODY [illegible] TAKEN CARE OF [illegible]

```
20   IF  [illegible] ABS(RC1) ) 9830,22,22

22   IF  [illegible] ABS(RC2) ) 983[illegible],24,2[illegible]

24   A[illegible] = [illegible] / SQRT([illegible]**2+(R[illegible])**2)
     RF= [illegible] )/ SQRT((YF[illegible])**2+(RF[illegible])**2)
9840 C[illegible]= [illegible]**2)-[illegible]EF*(Y2-Y1)**2
     C2=[illegible]
     C3= [illegible]**2)+[illegible](Y2-Y1)**2
     C4= [illegible]
     C5= [illegible])**2-(R2**2[illegible])**2)
     C6 = 2.*[illegible]
     C7=[illegible](R2**2+[illegible])**2'+2.*(Y2-Y1)*R1**2+2.*EF*F[illegible](Y2-Y1)**2
    C8= [illegible]
     C9= [illegible]**2)*(Y2-Y1)**2-(Y1*[illegible])**2+(Y[illegible])**2-2.*Y1*Y2*
   1  [illegible]
     C1  = 2.*[illegible]**2
     AAF= C2**2.*C6*C4*C2*C5+C4**2*C10
     [illegible]= [illegible]*C2**2*C5+C4*(C1*C8+C2*C7)+(C3*C2*C8)+C9*
   1  C4*[illegible]
     [illegible]= [illegible]*C2*C5-C1*C7*C4-C3*(C1*C8+C2*C7)-2.*C9*C3*C4
   1 +C3*[illegible]
     [illegible]= [illegible]**2[illegible]C3*C3**2*C9
     CAL  [illegible](AAF,[illegible],[illegible],[illegible],R[illegible],R[illegible]2,RR3,IC)

     [illegible](RR[illegible],RR[illegible],RR[illegible]),983[illegible],IC

9841 CALL ARCCOS(RR3,PHID,ITAIL)
```

```
      IF(ITA [illegible]) 9842,9842,9851

9842  [illegible]=[illegible]3

      IF(ABS([illegible]) .GE. 1.0E-05) GO TO 9851

      YF= [illegible]2*[illegible]/ EC
      CALL TEST2(YF[illegible],YFC,YF,IFY)

      IF(IFY -1) 9843,9843,9851

9843  CALL TEST2(Y1,Y2,YF,L[illegible]1)

      IF([illegible]-1) 500,500,9851

500   CALL CHECK( [illegible],[illegible]),Y1,R1,Y2,R2,YF,AF,BF,EF,[illegible],IGO)

      IF(IGO-1) [illegible]50,9850,9851
```

```
 9851   CALL WRCDDS(RR2,PHID,ITA1)

        IF(ITA1 -1) 9852,9852,9861

 9852   DED=C3-C4*RR2

        IF (DABS(DED) .LE. 1.0D-05) GO TO 9861

        YF=(C1-C2*RR2)/DED
         CALL TEST2(YFL,YFD,YF,IFY)

        IF(IFY -1) 9853,9853,9861

 9853   CALL TEST2(Y1,Y2,YF,LOUT)

        IF (LOUT-1) 510,510,9861

 510    CALL CHECK(PHID,PHI1,Y1,R1,Y2,R2,YF,AF,BF,EF,FF,IGO)
```

```
      IF(IDD-1) 9850,9850,9861

9861  CALL ARCCOS(RR1,PHIO,ITA1)

      IF(ITA1 - 1) 9862, 9862, 9830

9862  DED=C3-C4*RR1

      IF(DABS(DED) .LE. 1.0D-05) GO TO 9830

      YF=(C1-C2*RR1)/DED
      CALL TEST2(YF,.YFD,YF,IFY)

      IF(IFY - 1) 9863, 9863, 9830

9863  CALL TEST2(Y1,Y2,YF,LOUT)

      IF(LOUT-  ...) 520,9830
```

```
 520     CALL CHECK(PHI0,PHI1,T1,R1,T2,R2,YF,AF,BF,EF,FF,IGO)

         IF(IGO-1) 9850,9850,9830

C  A VALID SOLUTION HAS BEEN FOUND.

 9850    ICN=2

         RETURN

C  NO VALID SOLUTION WAS FOUND.

 9830    ICN=3

         RETURN

         END
```

(ENTRANCE)

```
**CANSEE
      SUBROUTINE CANSEE(Y1,R1,Y2,R2,YF,RF,KI,KIL,JJ,ISEE)
      DIMENSION YF(2,5),RF(2,5)
      ID=0
      [illegible]
      [illegible]
      KK= KI
      R2T= R2

   50 RUT=RF(JJ,KK)
      RDT= RF(JJ,KK+1)
      YUT = YF(JJ,KK)
      YDT = YF(JJ,KK+1)

      GO TO 60

   50 RUT= - RF(JJ,KK)
      RDT = - RF(JJ,KK+1)
      YUT = YF(JJ,KK)
      YDT = YF(JJ,KK+1)

   60 YDEN = ( R2T -R1)/(Y2-Y1) -(RDT-RUT)/(YDT-YUT)

      IF( ABS(YDEN) -1.0E-03) 200,200,70

   70 YNUM = ( RUT*YDT-RDT*YUT)/(YDT-YUT)-(R1*Y2-R2T*Y1)/(Y2-Y1)
      YI = YNUM /YDEN
```

```
      IF(DABS( Y1-YI) -1.0D-03) 200,200,30

   30 IF(DABS(Y2-YI)-1.0D-03) 200,200,90

   90 CALL TEST2( YLT,YDT,YI,LILY)

      IF(LILY-1) 65,65,200

   65 CALL TEST2(Y1,Y2,YI,LARRY)

      IF(LARRY-1) 67,67,200

   67 IF(KICK-2) 120,125,130

  120 KK=K1
      KICK =2
      ID=1
      R2T =- R2
```

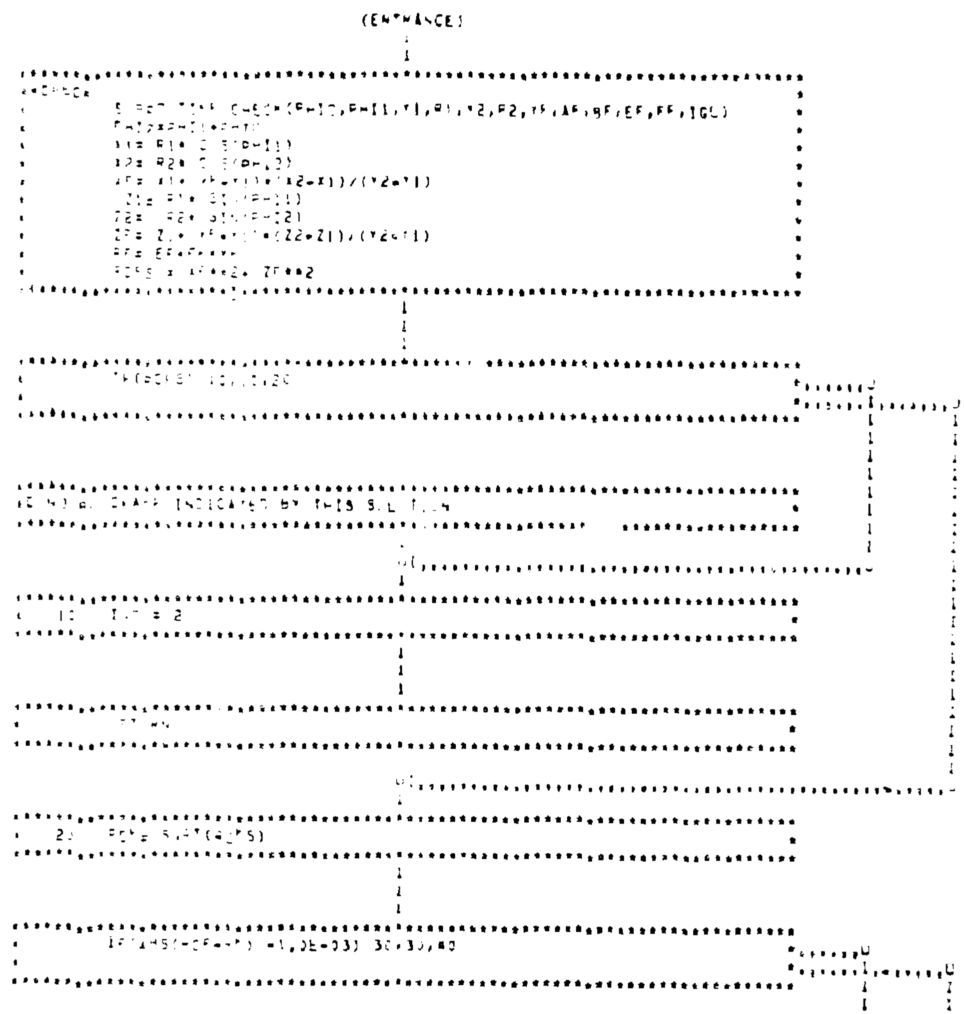
```
      GO TO 30

125 JD=1
      KICK =3
      KK=KI

      GO TO 50

130 JD=JD+1

      GO TO 155

200 IF(KK-KIL) 135,140,140

135 KK=KK+1

      IF(KICK-2) 30,30,50

140 IF(KICK-2) 145,150,155
```

```
145 KICK = 2
    R2I= -R2
    KK= K1

    GO TO 30

150 KICK= 2
    KK= K1

    GO TO 50

155 IF(ID) 160,160,165

160 IF(JD) 170,170,175

170 KK=K1

190 YJT=YF(JJ,KK)
    RJT=RF(JJ,KK)
    CALL TEST2(Y1,Y2,YJT,IFY)
```

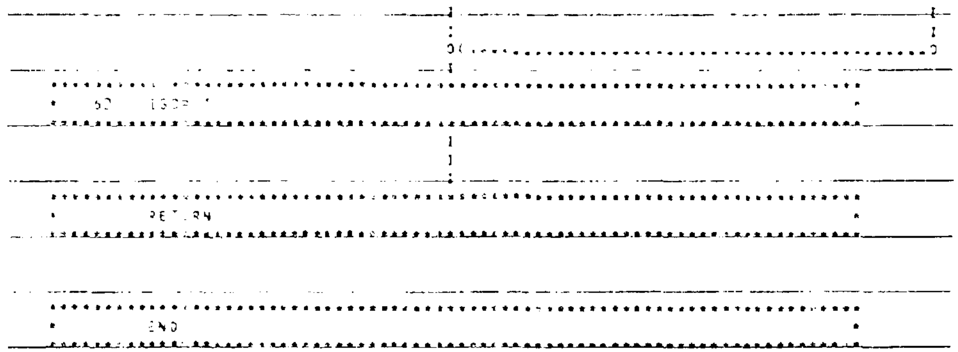
```
      IF(IFY-1) 201,201,195

  195 KK=KK+1

      IF(KK-KIL) 190,190,220

C  THE BODY CAUSES NO SHADOWING

  220 ISEE=1

      RETURN

  201 RO=  (Y2-YOT)*R1/(Y2-Y1)
      RHO= R2*(YOT-Y1)/(Y2-Y1)
      X1= RO+RHO
      X2= RO-RHO

      IF( ABS(ROT-X1)-1.0E-3) 195,195,205
```

```
205   IF( ABS(X2+RUT) -1.0E-03) 195,195,210

210   IF(X1-RUT) 220,220,230

230   IF(X2+RUT) 220,240,240

C THE FRUSTUM SHADOWS WITH ITS OUTSIDE SURFACE BUT SHADOWING DOES NOT EX
C FOR PHI2= 180 DEGREES AS IT DOES FOR ISEE=2

240   ISEE= 5

      RETURN

C THE BODY CAUSES SHADOWING WITH ITS OUTSIDE SURFACE

175   ISEE = 2

      RETURN
```

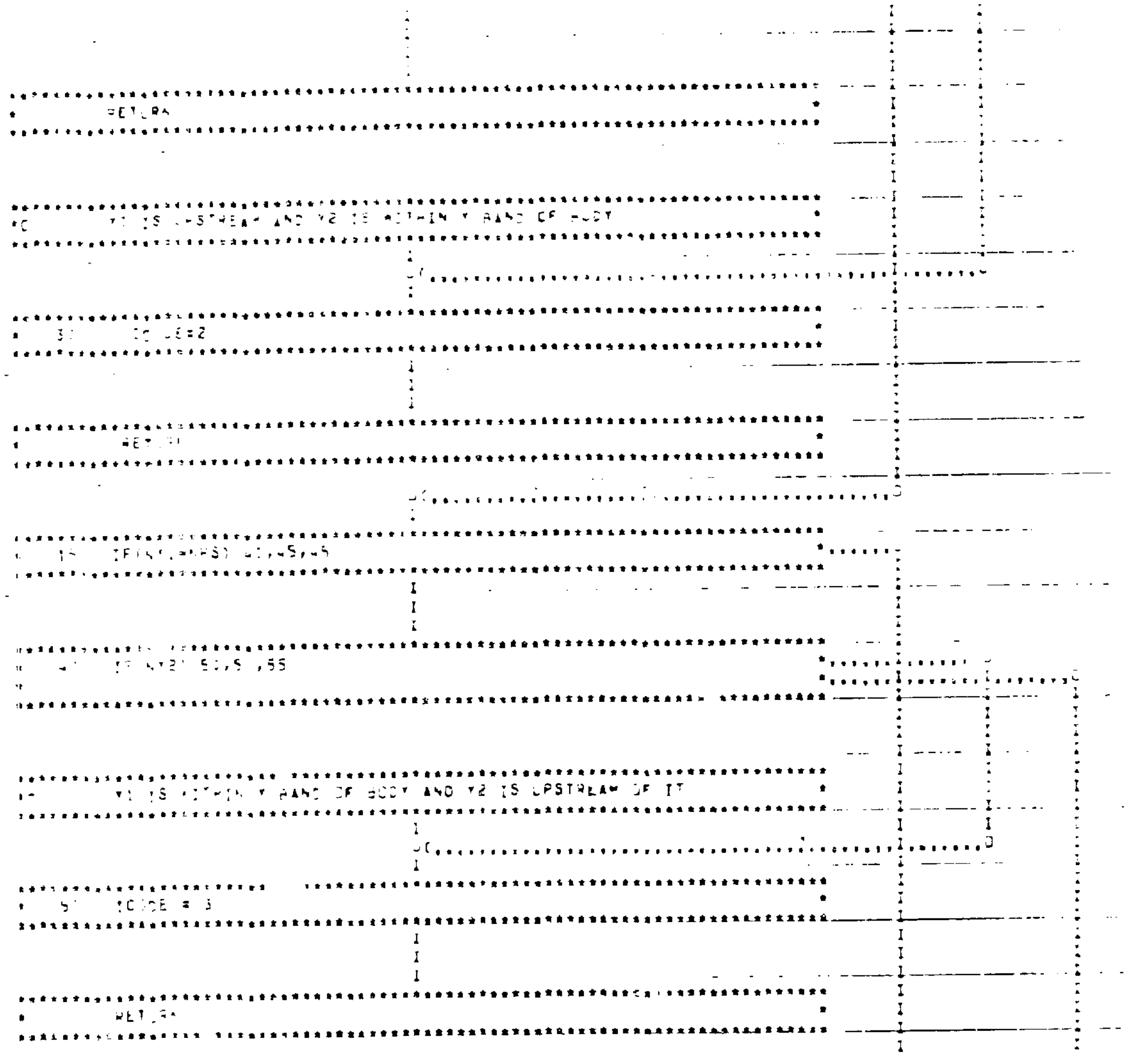
```
161  IF([illegible]) 180,180,185

C      THE BODY CAUSES SHADOWING WITH ITS INSIDE SURFACE

 180   ISEE=3

       RETURN

C      THE BODY CAUSES COMPLETE SHADOWING

 185   ISEE=[illegible]

       RETURN

       END
```


(ENTRANCE)

```
KC THE SOLUTION IS AN EXTRANEOUS SOLUTION FOR THIS PROBLEM

KC = 100 * 2

RETURN

30    CANL = (XI-X)*BF*XF/RF*AF+ YZ-Y)+(ZZ-Z)*BF*ZF/RF

IF (ABS(CANL-1.0E-7)) 50,60,50

KC THE SOLUTION IS AN EXTRANEOUS SOLUTION FOR THIS PROBLEM

50    KC = 2

RETURN

KC THE SOLUTION IS THE CORRECT SOLUTION TO THE PROBLEM
```

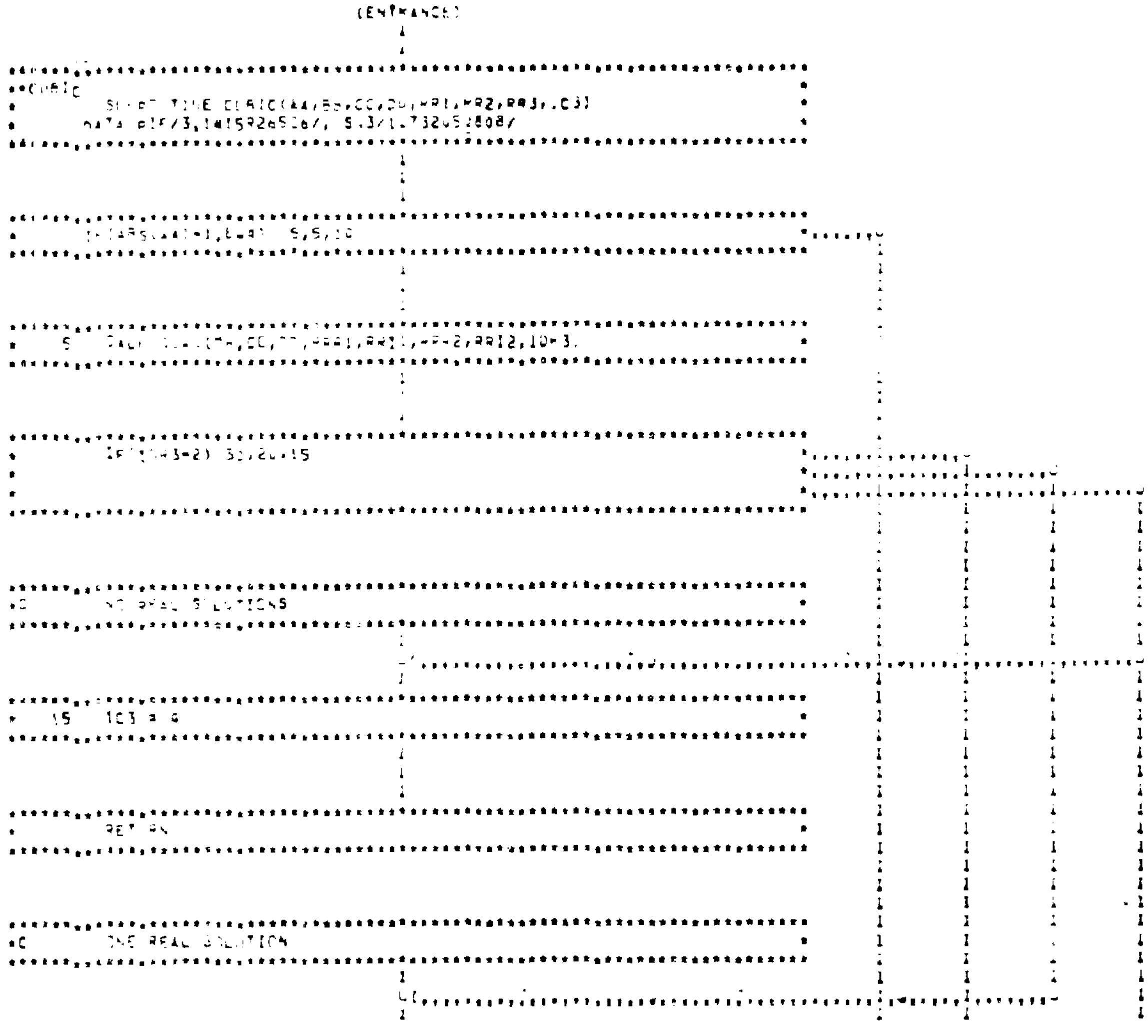

RETURN
END

```
(ENTRANCE)

SUBROUTINE CHORD(NY1,NY2,NPS,ICODE)

IF(NY1) 10,10,5

IF(NY2) 20,2 ,25

BOTH Y1 AND Y2 ARE UPSTREAM OF THE SHADOWING BODY

20   ICODE=A

RETURN

25   IF(NY2-NPS) 30,35,35

Y1 IS UPSTREAM AND Y2 IS DOWNSTREAM OF THE SHADOWING BODY
```


RETURN
Y1 IS UPSTREAM AND Y2 IS WITHIN Y BAND OF BODY
RETURN
Y1 IS WITHIN Y BAND OF BODY AND Y2 IS UPSTREAM OF IT
ICODE = 3
RETURN

```
55    IF(Y12*NPS) 60,65,60

C  Y1 IS WITHIN Y BAND OF BODY AND Y2 IS DOWNSTREAM OF IT

65    ICODE = 4

      RETURN

C     Y1 IS WITHIN Y BAND OF BODY AND Y2 IS ALSO WITHIN THAT BAND

60    ICODE = 5

      RETURN

      IF(Y12-NPS) 75,70,70

C     BOTH Y1 AND Y2 LIE DOWNSTREAM OF THE SHADOWING BODY
```

```
ICODE =5

RETURN

75   IF(NY2) 80,85,85

Y1 IS DOWNSTREAM OF BODY AND Y2 IS WITHIN THE Y BAND OF THE BODY

80   ICODE = 6

RETURN

Y1 IS DOWNSTREAM OF BODY AND Y2 IS UPSTREAM OF IT

85   ICODE = 7

RETURN
```


(ENTRANCE)
CUBIC
NO REAL SOLUTIONS
RETURN
ONE REAL SOLUTION

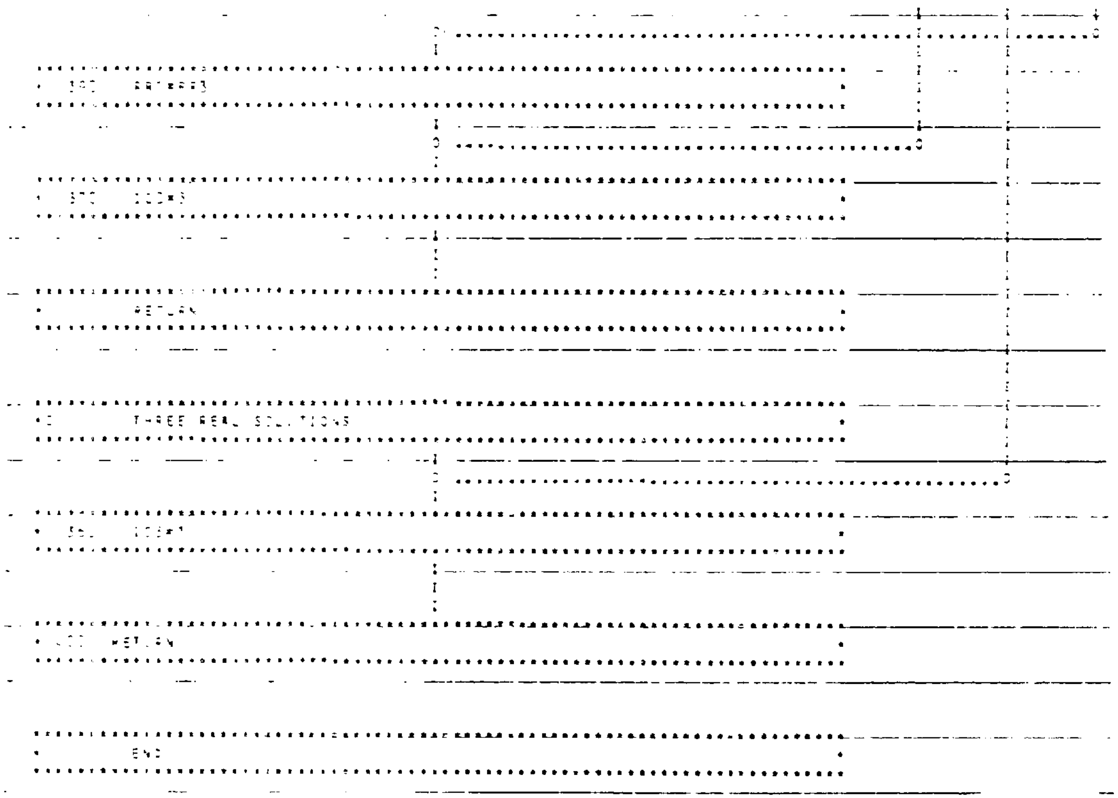
```
 20    ICI = 3
       RR1= RRR1

       RETURN

C      TWO REAL SOLUTIONS

 30    RR1= RRR1
       RR2 = RRR2
       ICI = 2

       RETURN

 10    BL = BB/AA
       CL = CC/AA
       DL= DD/AA
       P= CL-BL**2/3.
       Q= DL-BL*CL/3.+2.*BL**3/27.
       DISC = Q**2/4. +P**3/27.

       IF(DISC).40,50,[illegible]

 50    UA = -.5*Q
```

```
  110    T= ABS(UI3/UR3)
         RANG = ATAN(T)

         IF(UR3) 1<0,140,160

  140    ANG = PIE-RANG

         GO TO 200

  160    ANG = RANG

  200    ZETAR= [illegible] COS(ANG/3.)
         ZETAI= [illegible] SIN(ANG/3.)
C        THREE REAL SOLUTIONS
         I=3=1
         [illegible] = 2.*ZETAR
         ETA2 = -ZETAR -SQ3*ZETAI
         RR1= ETA1-[illegible]/3.
         RR2= ETA2-[illegible]/3.
       RR3=-RR1-RR2-R[illegible]

         RETURN

   60    [illegible]A = -.5*[illegible] SQRT(DISC)
```

```
80   IF(UA) 220,230,240

230  UA=-1.-UA

     IF(UA) 220,225,240

     ONE SOLUTION

225  IC3= 3
     RR1=0.

     RETURN

220  ZET1R = 0.5*(-UA)**(1./3.)
     ZET1I=ZET1R*SQ3

     GO TO 245
```

```
240    ZET1R= (UA)**(1./3.)
       ZET1I = 0.0

245    ZET2R = -.5*ZET1R -.5*SQ3*ZET1I
       ZET2I = -.5*ZET1I + .5*SQ3*ZET1R
       ZET3R = -.5*ZET1R +.5*SQ3*ZET1I
       ZET3I= -.5*ZET1I-.5*SQ3*ZET1R
       UA=P/(3.*(ZET1R**2+ZET1I**2))

       IF(ABS(UA+1.).GT.1.0D-4) GO TO 300

       RR1=ZET1R*(1.-UA)-BL/3.
       K=1
       IND=1

300    CONTINUE
       UA=P/(3.*(ZET2R**2+ZET2I**2))

       IF(ABS(UA+1.).GT.1.0D-4) GO TO 320

       RR2=ZET2R*(1.-UA)-BL/3.
       K=K+1
       IND=2
```

```
  320  CONTINUE
       UA=P/(3.*(ZET3R**2+ZET3I**2))

       IF(ABS(UA+1.).GT.1.0D-4) GO TO 340

       RR3=ZET3R*(1.-UA)-BL/3.
       K=K.+1
       IND = 3

  340  IF(K-2)  350,350,360

C      ONE REAL SOLUTION

  350  GO TO(370,347,390),IND

  360  RR1=RR2

       GO TO 370
```


RETURN
THREE REAL SOLUTIONS
RETURN
END

(ENTRANCE)

```
FUNCTION DARC(A)
DARC=ABS(A)
```

RETURN

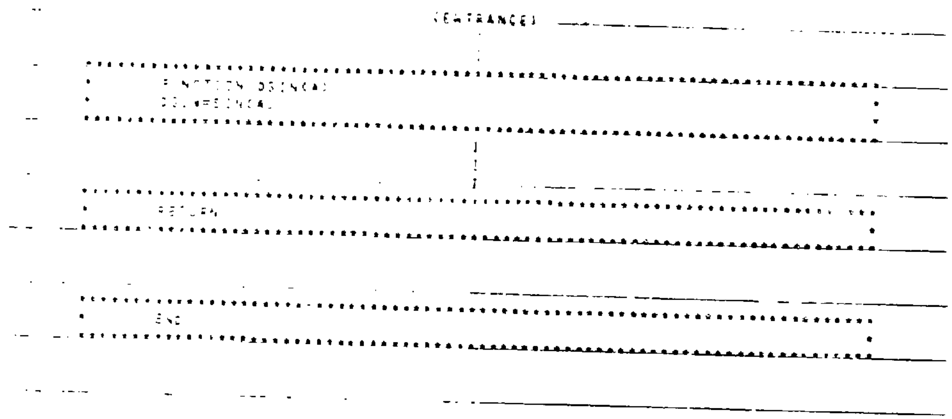
END

(ENTRANCE)

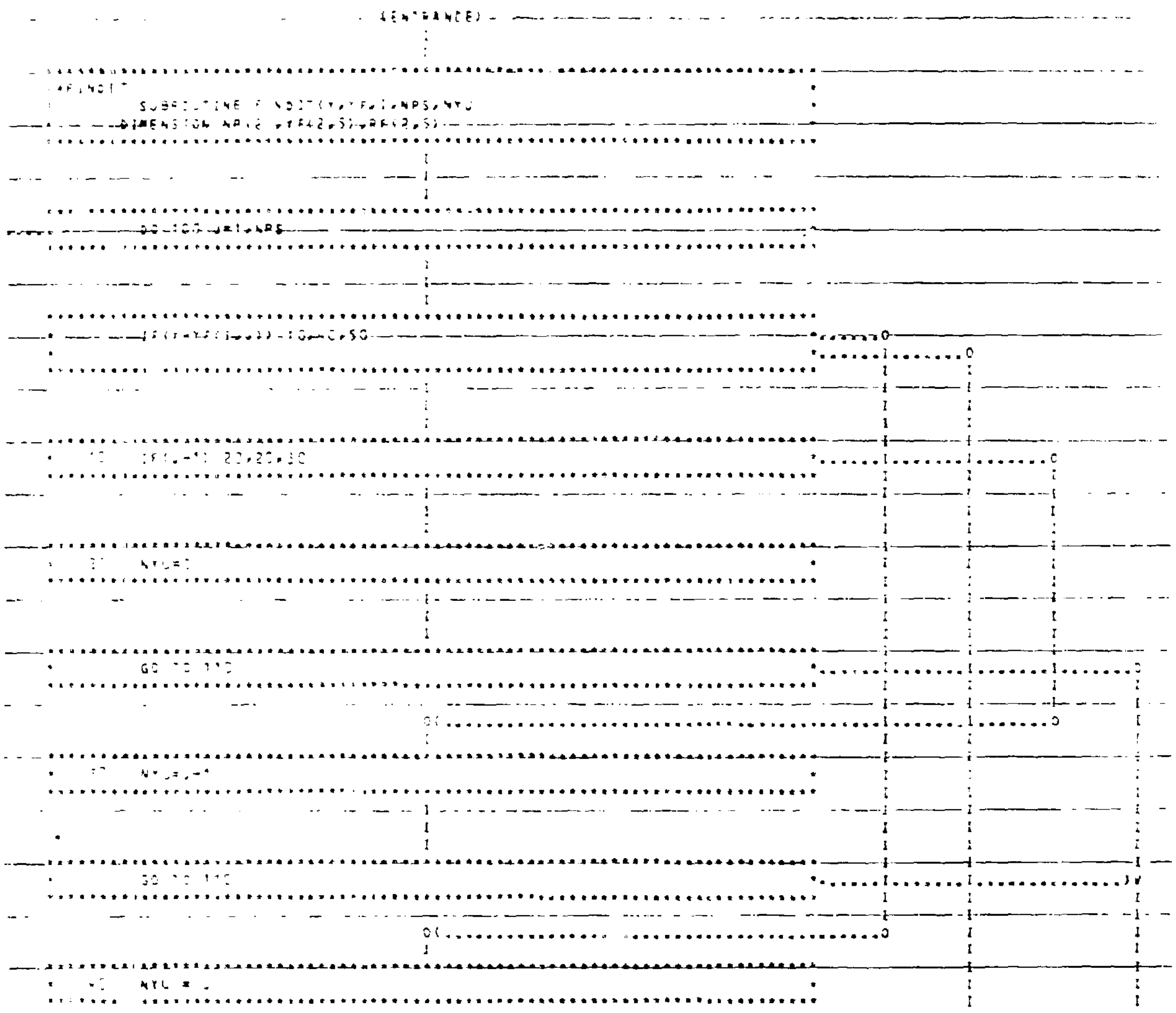
FUNCTION DCOS(A)
DCOS=COS(A)

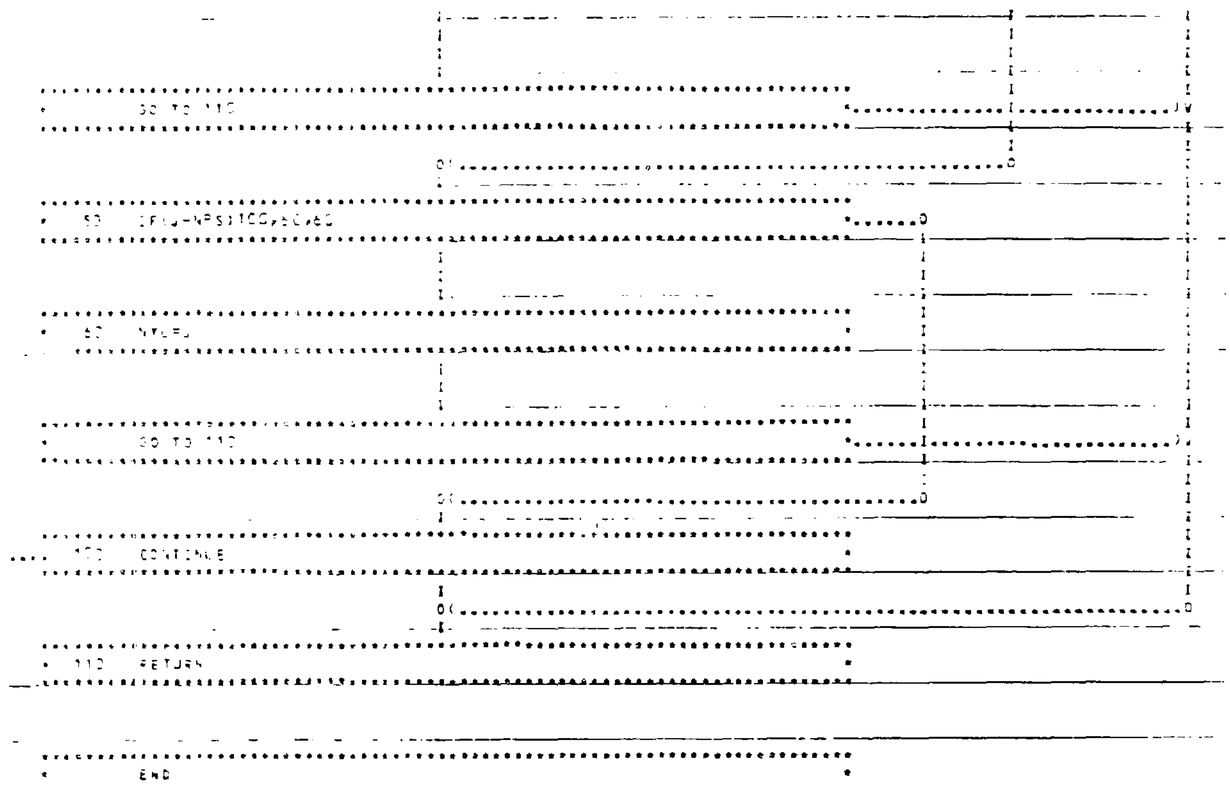
RETURN

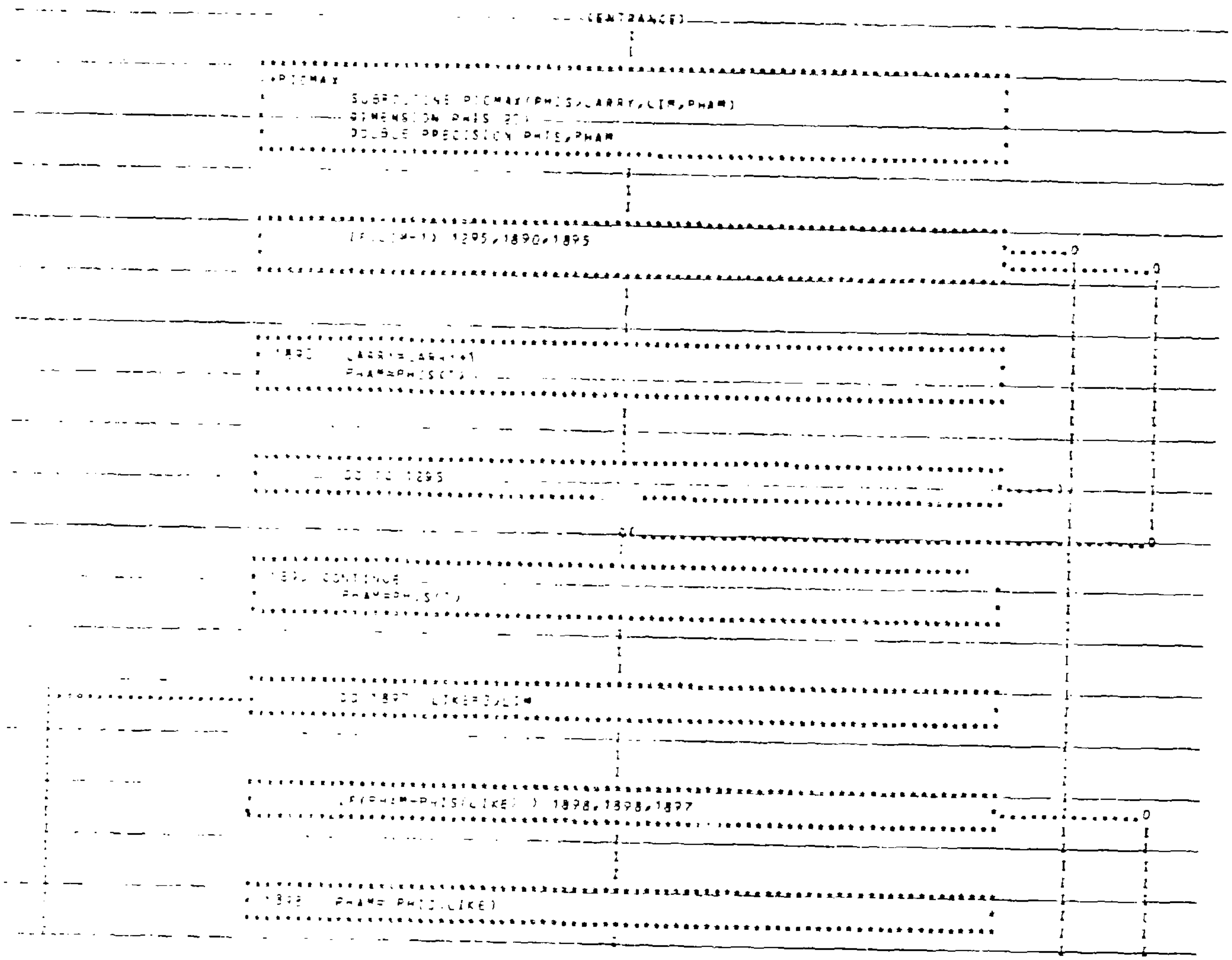
END

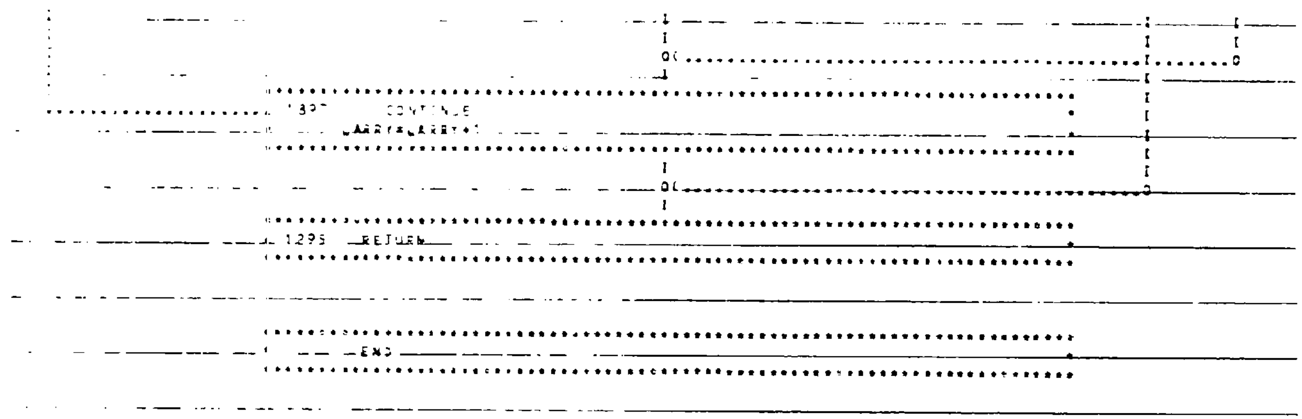

(ENTRANCE)
RETURN
END

```
(ENTRANCE)

FUNCTION DSQRT(A)
DSQRT=SQRT(A)

RETURN

END
```

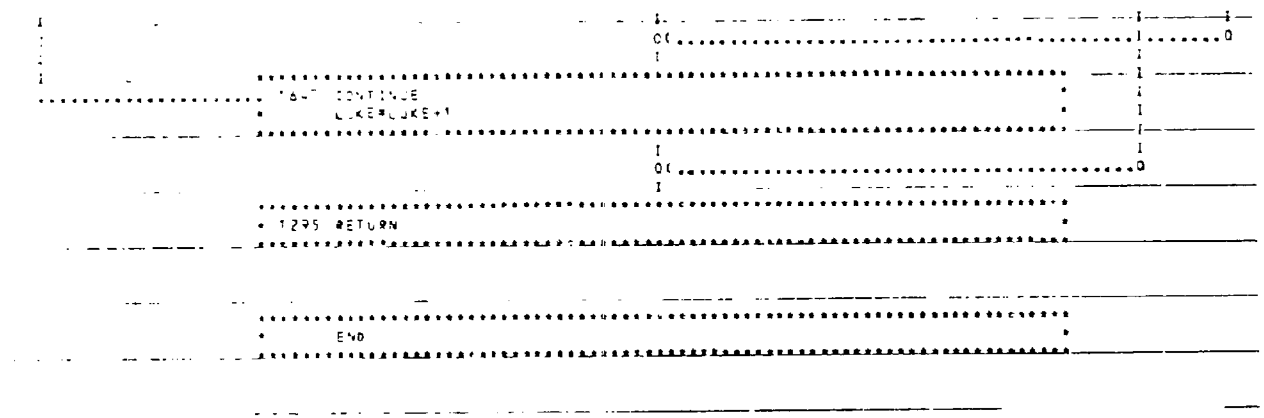

(ENTRANCE)
SUBROUTINE
DIMENSION


GO TO 110
50 IF(J-NPS)100,60,60
60 NYL=J
GO TO 110
100 CONTINUE
110 RETURN
END


(ENTRANCE)
PICMAX
SUBROUTINE PICMAX(PHIS,LARRY,LIM,PHAM)
DIMENSION PHIS(20)
DOUBLE PRECISION PHIS,PHAM
IF(LIM-1) 1895,1890,1895
1890 LARRY=LARRY+1
PHAM=PHIS(1)
GO TO 1895
1895 CONTINUE
PHAM=PHIS(1)
DO 1897 LIKE=2,LIM
IF(PHAM-PHIS(LIKE)) 1898,1898,1897
1898 PHAM= PHIS(LIKE)


CONTINUE
1295 RETURN
END

```
(ENTRANCE)

PICMIN
      SUBROUTINE PICMIN(PHEO,LUKE,LUM,PHIM)
      DIMENSION PHEO(20)

      IF(LUM -1) 1295,1620,1630

1620  LUKE=LUKE+1
      PHI = PHEO(1)

      GO TO 1295

1630  CONTINUE
      PHIM= PHEO(1)

      DO 1640  LINK=2,LUM

      IF(PHIM-PHEO(LINK)) 1640,1650,1650

1650  PHIM= PHEO(LINK)
```


1647 CONTINUE
LUKE=LUKE+1
1295 RETURN
END

```
(ENTRANCE)

QUAD
      SUBROUTINE QUAD(A,B,C,RR1,RI1,RR2,RI2,IDF)

      IF( ABS(A)-1.0E-08) 5,5,30

  5   IF( ABS(B) -1.0E-04) 10,10,15

C     NO SOLUTION

 10   IDR=4

      RETURN

C     ONE REAL SOLUTION

 15   RR1=-C/B
      IDR=2

      RETURN
```

```
30  DISC = B*B-4.*A*C

    IF(DISC) 40,50,60

C   COMPLEX ROOTS

40  IDR=3
    RR1 = -B/(2.*A)
    RI1 = .5* SQRT(-DISC)/A
    RR2= RR1
    RI2 = -RI1

    RETURN

C   IDENTICAL ROOTS

50  IDR =2
    RR1 = -B/(2.*A)

    RETURN
```

```
C        TWO REAL ROOTS

*    60    IRF = 1
*          RR2= SQRT(DISC)
*          RR1=.5*(-B+RR2)/A
*          RR2=.5*(-B-RR2)/A

*          RETURN

*          END
```

```
(ENTRANCE)

RING
      SUBROUTINE RING(Y1,R1,Y2,R2,YF,RF,PHI,LOU)
      RC=(Y2-YF)*R1/(Y2-Y1)
      RHC= R2*(YF-Y1)/(Y2-Y1)

      IF(RF-(RC-RHC)) 10,10,20

C THE CONE OF VISION DOES NOT INTERSECT THE SHADOWING FRUSTUM FOR THIS YF
C THIS APPLIES TO OUTSIDE SHADOWING ONLY

   10 LOU=2

      RETURN

   20 XF= 0.5*(RC+RF*RF/RC-RHC*RHC/RC)
      ZFS= RF**2-XF**2

      IF(ZFS) 30,40,40

C THE CONE OF VISION COMPLETELY SURROUNDS THE SHADOWING FRUSTUM FOR THIS
C FOR OUTSIDE SHADOWING OR THE CONE OF VISION LIES INSIDE THE SHADOWING
C FRUSTUM FOR THIS YF FOR INSIDE SHADOWING
```

```
   30   LDU = 1

        RETURN

   40   X2R= R1+(Y2-Y1)*(XF-R1)/(YF-Y1)
        CS= X2R/R2
        CALL ARCCOS(CS,PHI,IDA)

              JA-1) 50,50,60

C SOMETHING IS WRONG WITH THE SOLUTION OBTAINED FOR X2R.

   60   LDU=3

        RETURN

C - SOLUTION FOR RING SHADOWING HAS BEEN FOUND.
```

53 LOOP.4

RETURN

END

```
(ENTRANCE)

TEST
      SUBROUTINE TEST1(R1T,R2T,PHIOT,PHI1T,X1T,Z1T,ITEST)
        DENO = R2T**2+R1T**2-2.*R2T*R1T* COS(PHIOT)

      IF(DENO) 20,20,10

 10   PHI2= PHI1T+PHIOT
      DENO=(R1T*R2T* SIN(PHIOT))/DENO
        X2T= R2T* COS(PHI2)
        Z2T = R2T* SIN(PHI2)
      XF=DENO*(Z2T-R1T* SIN(PHI1T))
      ZF=-DENO*(X2T-R1T* COS(PHI1T))
        D1F =  SQRT((X1T-XF)**2+(Z1T-ZF)**2)
        D2F=  SQRT((X2T-XF)**2 (Z2T-ZF)**2)
        D12 =  SQRT((X2T-X1T)**2+(Z2T-Z1T)**2)

      IF( ABS(D1F-D12) -1.0E-03) 11,11,12

 11   D1F= D12

 12   IF( ABS(D2F-D12)-1.0E-03) 13,13,14

 13   D2F= D12
```

```
14   IF(D1F-D12) 15,15,20

15   IF(D2F-D12) 25,25,20

     SOLUTION IS NOT VALID FOR THIS PROBLEM

20   ITEST = 2

     RETURN

C    SOLUTION IS VALID FOR THIS PROBLEM

25   ITEST = 1

     RETURN

     END
```

```
(ENTRANCE)

**TEST2
        SUBROUTINE TEST2(YU,YD,YF,IFYF)
        YUYD= DABS(YD-YU)
        YFYD = DABS(YD-YF)
        YFYU = DABS(YU-YF)

        IF(DABS(YUYD-YFYD)-1.0D-03) 1,1,2

    1   YFYD= YUYD

    2   IF(DABS(YUYD-YFYU)-1.0D-03) 3,3,4

    3   YFYU= YUYD

    4   IF(YFYD-YUYD) 5,5,10

    5   IF(YFYU-YUYD) 15,15,10

*C      YF IS NOT A VALID SOLUTION FOR THIS PROBLEM
```

```
10   IFYF=2

     RETURN

C    YF IS A VALID SOLUTION FOR THIS PROBLEM

15   IFYF = 1

     RETURN

     END
```

```
(ENTRANCE)

*SHADOW
      SUBROUTINE SHADOW(NNN,NP,YF,RF,NF,YFA,YFB,RFA,RFB)
      DIMENSION NP(1),YF(2,8),RF(2,8),YFA(1),YFB(1),RFA(1),RFB(1)
      DIMENSION NP(2)
    1 NF=0

      DO 20 I=1,NNN

      KK=1
      K=2
      NPP=NP(I)-1

    7 IF(K.GT.NPP) GO TO 12

    5 CH1=RF(I,K)-RF(I,KK)

      IF(CH1.EQ.0.0) GO TO 15

      TH1=(YF(I,K)-YF(I,KK))/CH1

      GO TO 16
```

```
15   TH1=0.
16   KS=K
     DO 10 J=KS,MPP
     CH2=RF(I,J+1)-RF(I,J)
     IF(CH2.EQ.0.) GO TO [illegible]
     TH2=(YF(I,J+1)-YF(I,J))/CH2
     GO TO 18
17   TH2=0.
18   TH=ABS(TH1-TH2)
```

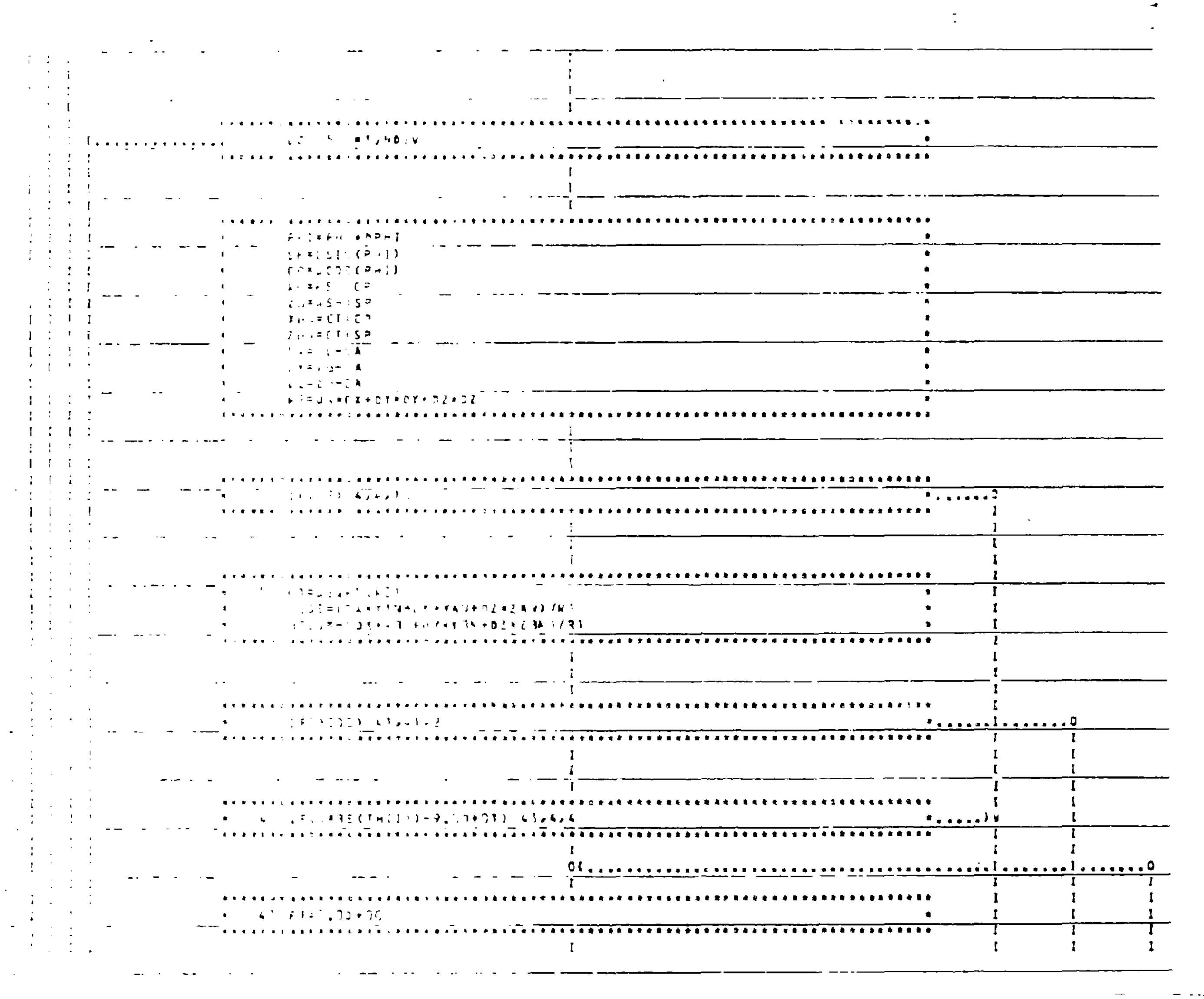
```
      IF(TM.LE..0001) GO TO 10

    3 NF=NF+1
      YFA(NF)=YF(I,KK)
      YFB(NF)=YF(I,J)
      RFA(NF)=RF(I,KK)
      RFB(NF)=RF(I,J)
      KK=J
      K=J+1

      IF(J.EQ.NPP) GO TO 12

      GO TO 7

   10 CONTINUE

   12 J=NPP+1
      NF=NF+1
      YFA(NF)=YF(I,KK)
      YFB(NF)=YF(I,J)
      RFA(NF)=RF(I,KK)
      RFB(NF)=RF(I,J)

   20 CONTINUE
```

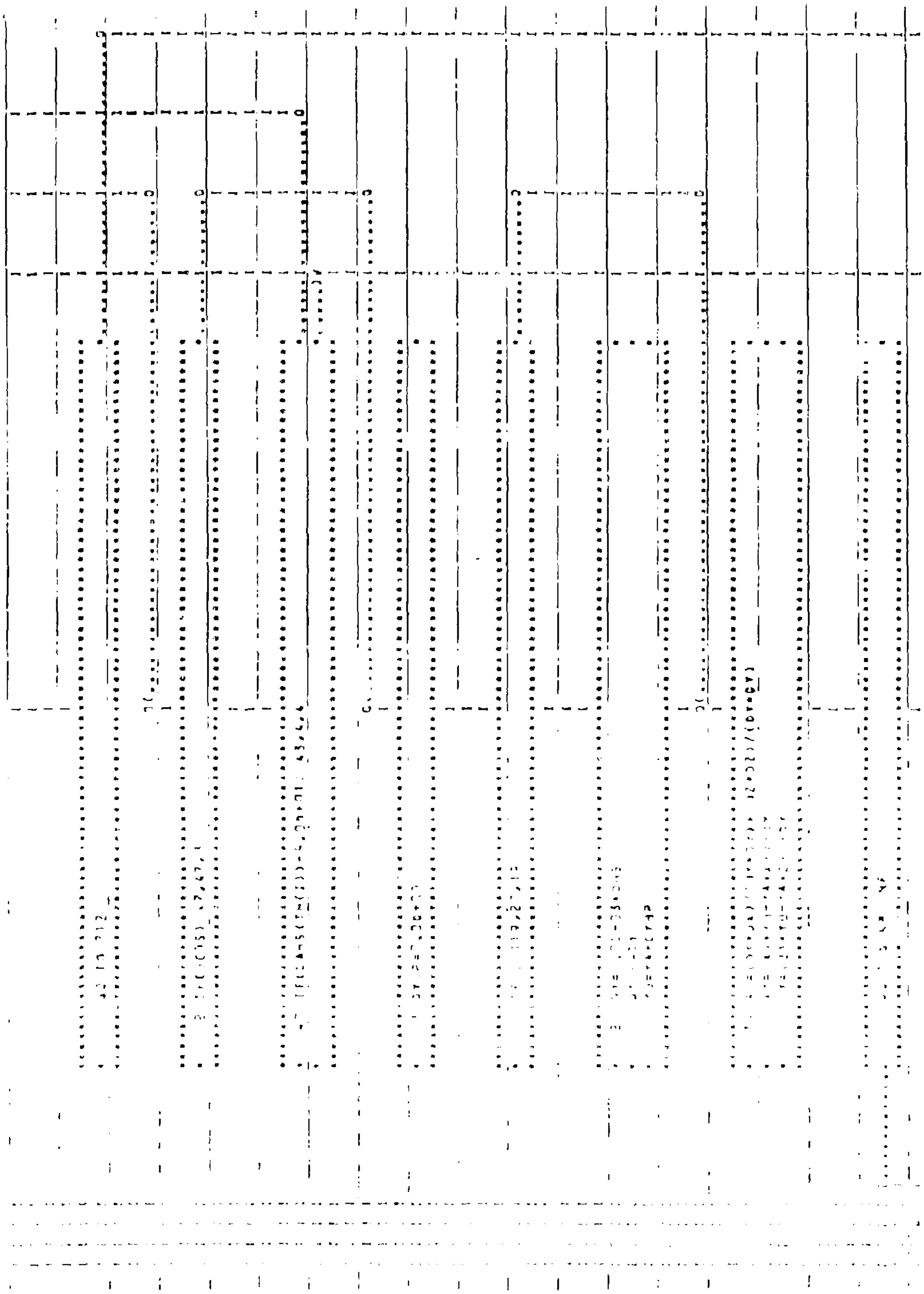
RETURN

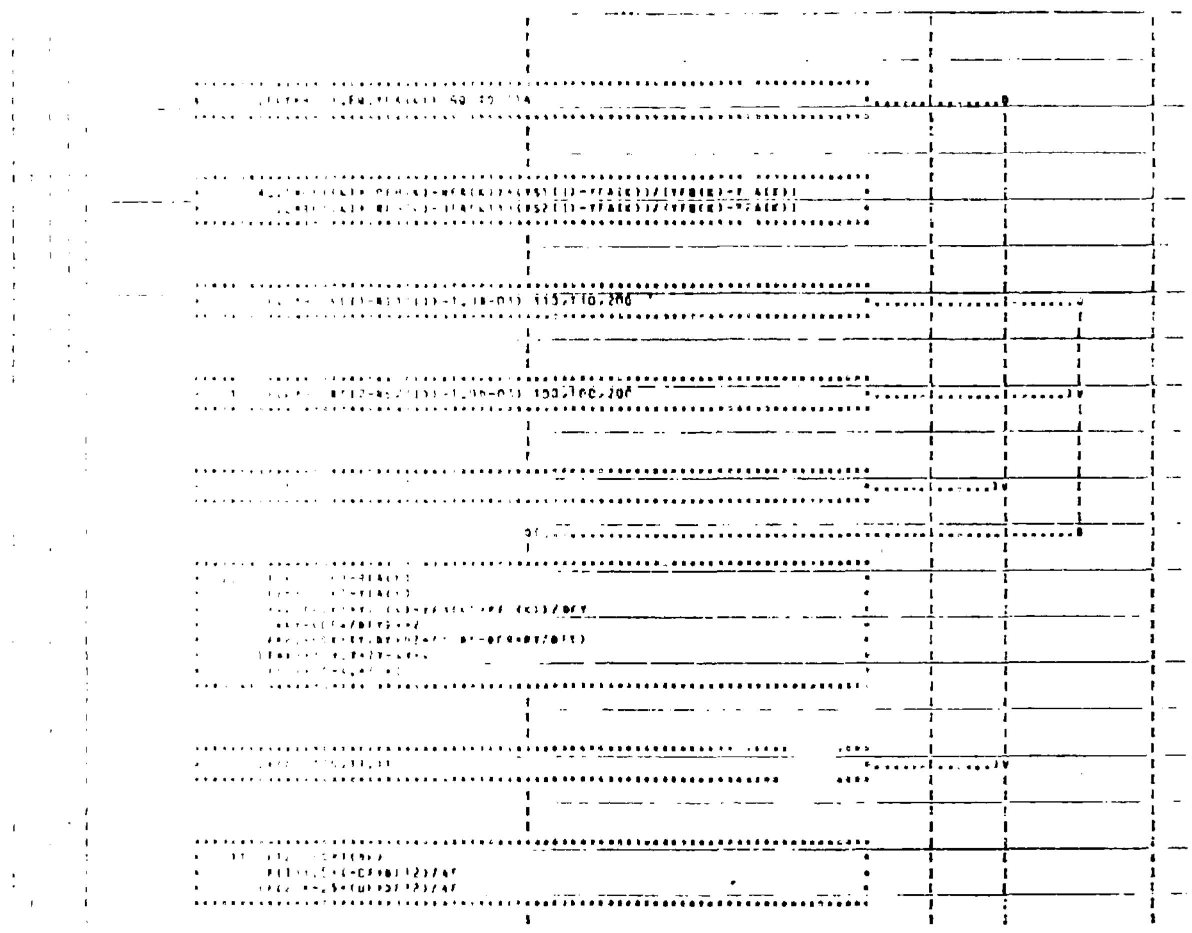
END

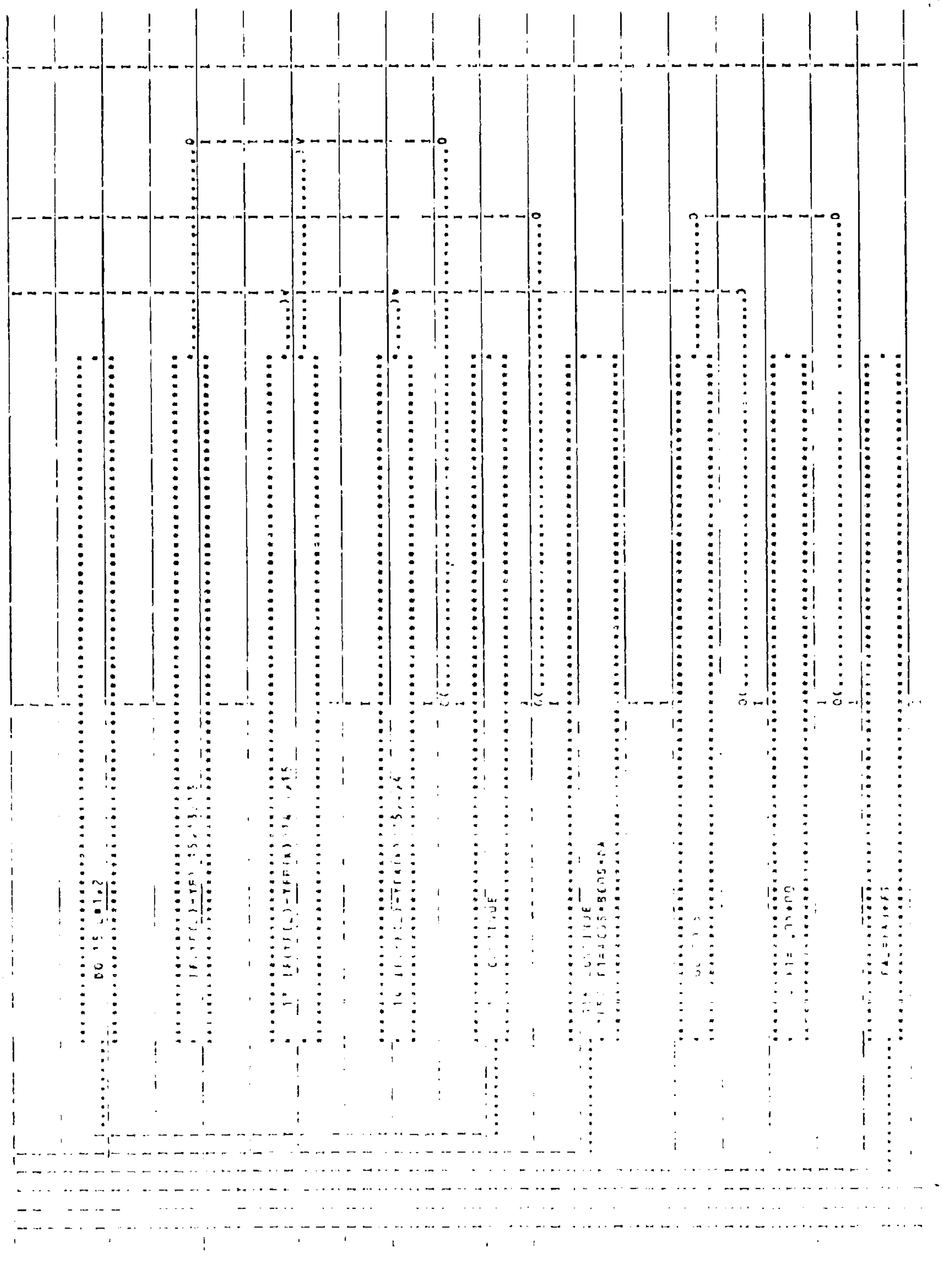
```
(ENTRANCE)

      SUBROUTINE REDUI(YS1,RS1,YS2,RS2,VECT,NSEC,NF,RFA,RFB,YFA,YFB,
     1 NOD,IPLANE,IS,INN,THA,PRINTB,FE)
      DIMENSION YS1(8),YS2(8),RS1(8),RS2(8),
     *          RFA(1),RFB(1),  (10),THA(1),YFB(1),YF(2),NDIV(8)
      DIMENSION YFA(1),VECT(1),NODE(1),FE(10,8)
      DATA NDIV/18/
      RE=5.0
      PIE=3.14159265358979
      DPHI=PIE/18.

      DO    I=1,NSEC

      IV=YS2(I)-YS1(I)

      IF(IV.EQ.0) GO TO 10

      IV=ABS(RS2(I)-RS1(I))
      IF(IV.EQ.0) IV=1

   10 CONTINUE

      NDIV(I)=IV
      CALL VECANG(YS1,RS1,YS2,RS2,VECT,TH,NSEC)
      TH2

   33 DO 37 K=1,KA2
```

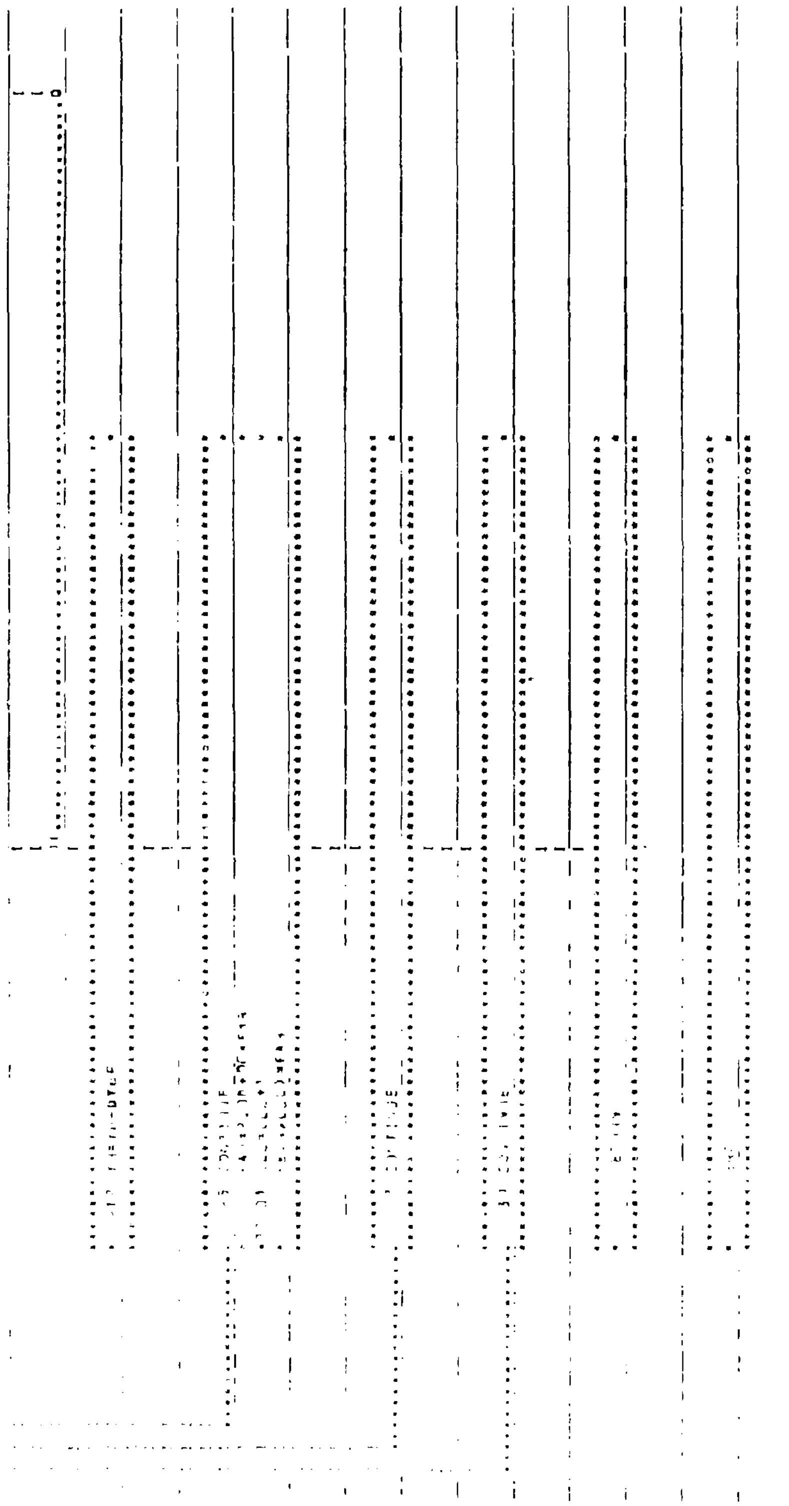
```
      CALL [illegible]
20 [illegible] THA=PIE*THP(M)/180.D+00
      ST=DSIN(THA)
      CT=DCOS(THA)
      XA=RE*ST
      YA=YPL+RE*CT
      ZA=0.0D+00
      XAN=-ST
      YAN=-CT
      ZAN=0.0D+00

      DO 7 I=1,NSEC

 612  S=[illegible]0.0
 625  TAU=[illegible]*PIE/1.8D+02
      CT=DCOS(TAU)
      ST=DSIN(TAU)
      [illegible]=(-S2(I)-XS1(I))/HDIV(I)
      [illegible]=(-YS2(I)-YS1(I))/HDIV(I)
      [illegible]=XS1(I)-.5*D[illegible]
         [illegible]=HDIV(I)
      PHJ=DSQRT(DRH*DRH+DYH*DYH)
      [illegible]=0.0D+00
      [illegible]=[illegible](I)-.5D+00*DP[illegible]
      [illegible]=-S[illegible]

      DO 25 IS=1,NH

      [illegible]=[illegible]*G
      RSJ=RSJ+DRB
      CA=[illegible]+RSH*DH[illegible]
      PHI=-.5*DFH[illegible]
```

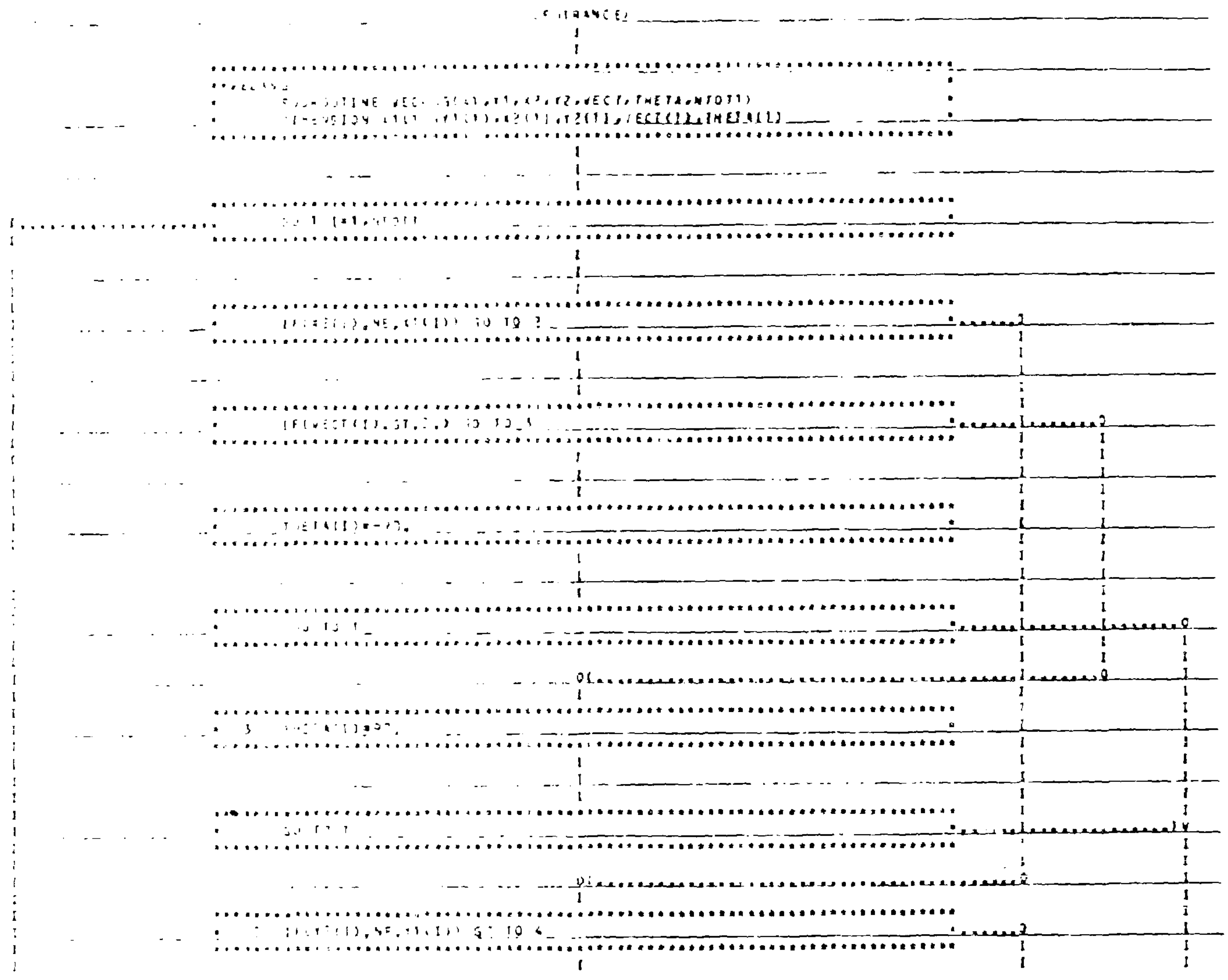




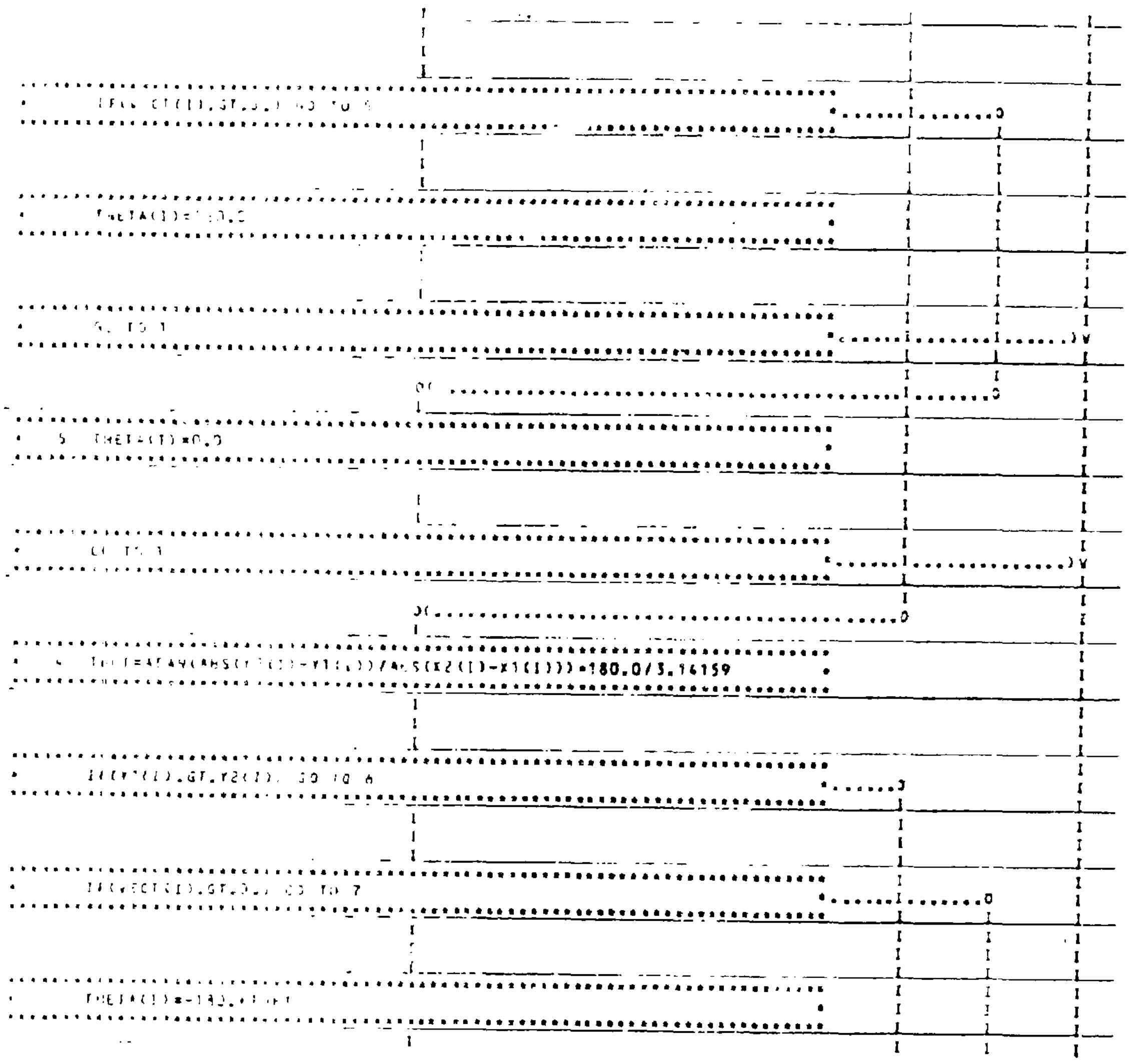


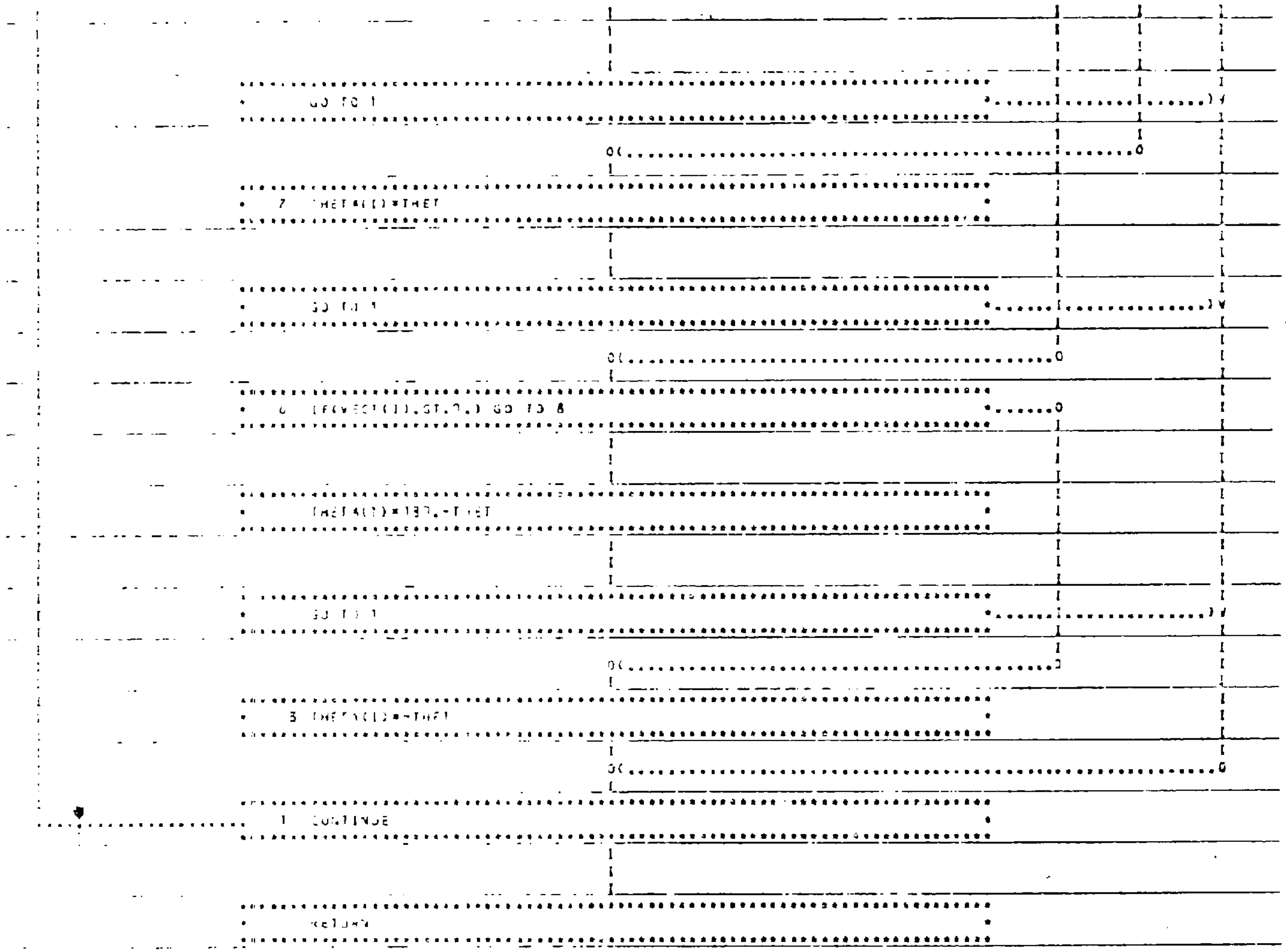






(ENTRANCE)
VECT,THETA,NTOT1)
VECT(1),THETA(1)
IF(VECT(I).GT.0.) GO TO 5
THETA(I)=-90.


IF(VECT(I).GT.0.) GO TO 5
THETA(I)=90.0
GO TO 1
5 THETA(I)=0.0
GO TO 1
4 THETA(I)=ATAN(ABS(Y2(I)-Y1(I))/ABS(X2(I)-X1(I)))*180.0/3.14159
IF(Y1(I).GT.Y2(I)) GO TO 6
IF(VECT(I).GT.0.) GO TO 7
THETA(I)=-180.+THETA


GO TO 1
7 THETA(I)=THET
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6 IF(VECT(I).GT.0.) GO TO 8
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